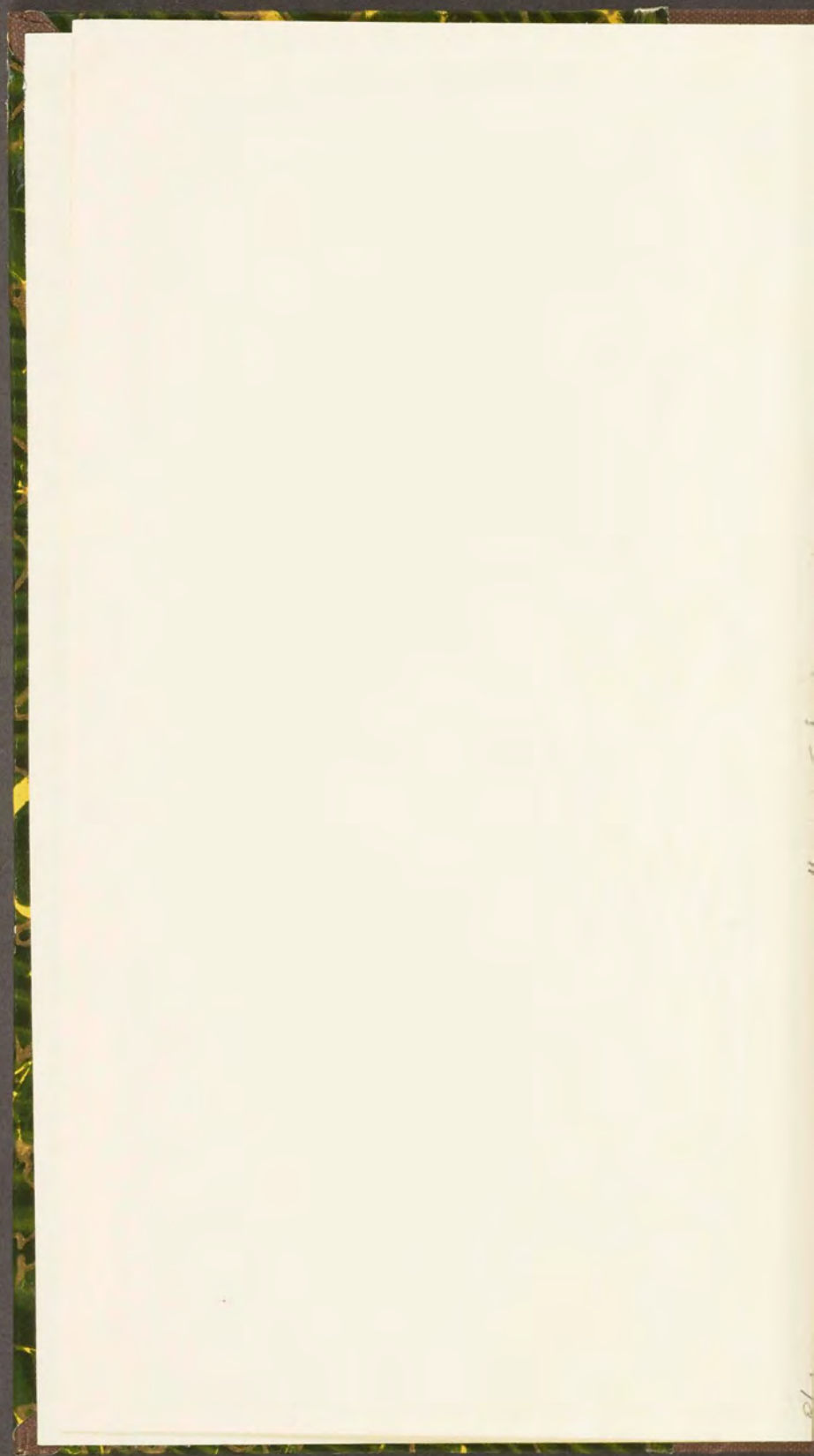


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DE
SILICIAE AEQUIVALENTO
ET FORMULA CHEMICA
COMMENTATIO

QUAM PRO
OBTINENDA FACULTATE DOCENDI

IN
UNIVERSITATE LITTERARUM IENENSI

DIE XXIX. M. DECEMBRIS A. MDCCCLII

PUBLICICE DEFENDET

AUCTOR

HERMANNUS LUDWIG,

PHILOSOPHIAE DOCTOR.



IENAE,
TYPIS SCHREIBERI.

Deus omnia mensura et numero et pondere
disposuit.

LIB. SAPIENT. cap. 11. 22.

VIRO

SUMMUM VENERABILI

FRID. AUGUSTO HOLZHAUSEN

DR. PH. THEOLOG. LIC. IN LITTERAR. UNIVERS.

GOTTING. SOCIO ORDINARIO SOCIETATIS

HISTORICO - THEOLOG. LIPS.

AVUNCULO DILECTISSIMO

HANC DISSERTATIONEM

SACRAM ESSE VULT

AUCTOR.

PROOEMIUM.

§. I. In studiis siliciae ejusque combinationum aequae chemicis ac mineralogis geologisque haud paucae obferuntur difficultates eo, quod neque aequivalentum illius nec formula chemica adhuc extra omnem controversiam posita sunt. Quamquam in stuporem rapimur, cum tot tantaque siliciae combinationum genera, quanta reperiuntur in rerum natura, perpenderimus, quamquam chemicorum et mineralogorum observationibus de novis silicatum generibus in dies paene edocemur, attamen summopere offendimur formulis silicatum diversis atque inter se repugnantibus, quippe quae excogitatae esse videantur ita ut ea, quae istis significantur, potius obscurentur, quam clara exponantur. Mirum in modum hic quadrat dictum TALLEYRAND: „la parole nous a été donnée pour cacher nos pensées.“

In his pro viribus meis exposui, quae de natura siliciae chemica habui, unde fortasse controversiae, quae circa ejusdem aequivalentum formulamque vigent, aliqua ex parte componi queant.

Cap. I.

Quaedam de silicia in universum disputata.

§. 2. Silicia seu acidum silicicum seu oxydum silicii unica quae adhuc innotuit combinatio silicii cum oxygenio est. Secundum analyses BERZELII, HENRICI ROSE et STROMEYER continent centum ejusdem partes *)

	sec. BERZELIUM.	H. ROSE.	STROMEYER.
Silicium	— 48,275 —	49,72 —	46
Oxygenium	— 51,725 —	50,28 —	54
	100,000	100,00	100

Ex pluribus siliciae indagationibus BERZELIUS silicii aequivalentum deduxit = 277,778 (qua in re oxygenii aequivalentum = 100 posuit, formulamque SiO^3 siliciae imposuit). Si hunc numerum sequemur, tum compositio siliciae in 100 partibus haec est:

$$\text{Si} = 277,778 = 48,078$$

$$\text{O}^3 = 300,000 = 51,922$$

$$\text{SiO}^3 = 577,778 = 100,000.$$

PELOUZE aequivalentum silicii eo constituit, quod silicii chloretum auxilio oxydi argenti nitratis decomposuit, unde illud = 88,94 (qua in re aequivalentum oxygenii = 100, siliciae vero formulam = SiO posuit). Aequivalento hydrogenii = 1 sumto silicii aequivalentum est =

$$\frac{88,94}{12,5} = 7,115. \text{ Nunc habes hanc sili-$$

$$\text{ciae compositionem: Si} = 7,115 = 47,072$$

$$\text{O} = 8 = 52,928$$

$$15,115 \quad 100,000.$$

*) Cf. Librum, qui inscriptus est: *Leopold Gmelin, Handb. der Chemie* ed. IV, vol. II, pag. 341.

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§. 3. Silicia duas modificationes exhibet:

a) *crystallinam*,

b) *amorphicam* seu *opalinam*.

Prima modificatio in regno naturali reperitur *crystallum montanum*, *Quarzum* etc., secunda in puris opali varietatibus una cum aqua conjuncta. Silicia e combinationibus suis chemice sejuncta plerumque adnumeranda est modificationi secundae (conf. observationem SENARMONT §. 4).

Silicia crystallina formas prae se fert mineralogico systemati hexagonali adscribendas. Pondus specificum crystalli montani est $\equiv 2,652$, in temperatura 4° C. in vacuo (DUMAS et LEROYER). Varietates crystalli montani purae perfecte pellucidae, incolores sunt. Idem crystallum *duplicem* refractionem radiorum solis exhibet. In altissimis caloris gradibus silicia crystallina funditur abitque in limpidam massam vitream, quae in filamenta deduci potest. Silicia per se ac sola etsi non volatilis, tamen in statu candescente, cum in tactum aquae vaporum venerit, commutatur in vapores, qua in re cum *acido boracico* similitudinem habet. Silicia crystallina in aqua non solvitur; idem accidit in contactu ejusdem cum acidis oxygeniferis; e genere acidorum hydrogeniferorum solummodo *acidum hydrofluoricum* actionem solventem in illam exercet, unde silicia in gas fluosilicicum mutatur.

Quarzi pulverisati perpauca tantum quantitas in lixivio kalico solvitur. —

Silicia amorphica, si e combinationibus suis chemice extracta est, pulverem album exhibet in tactu asperum, linguae non adhaerentem, insipidum. *Opalus* est semipellucidus *simplicemque* exhibet refractionem

radiatorum lucis. Silicia amorphica ex prioribus determinationibus KIRWANI pondus specificum 2.66, ex recentioribus Comitibus SCHAFFGOTSCH pond. spec. 2.19 — 2.23 exhibet. Densitas mineralium, quae *opali* vocantur, in statu subtilissime pulverisato, candescentia post, vacillat inter numeros 1,34 et 2,22; candescentiae diutius exposita silicia minus densa maiore densitate gaudet (SCHAFFGOTSCH)*). Silicia amorphica tali ratione quali silicia crystallina caloris actione funditur, neque in aqua, neque in acidis oxygeniferis solvitur. Acida hydrogenifera actionem in siliciam amorphicam non efficiunt, excepto acido hydrofluorico, quo celerius dissolvitur quam silicia crystallina. Lixivio kalico vel natrio silicia amorphica *facile* solvitur; idem accidit in fervidis solutionibus aquosis natri carbonatis. Hac maiori solvendi facultate in liquoribus alcalinis silicia amorphica distincte dignoscitur a silicia crystallina.

Silicia amorphica utpote residuum non solubile in aqua, acidis oxygeniferis et plurimis acidis hydrogeniferis *siliciae crystallinae fusione* cum alcalibus, terreno-alcalibusve, oxydove plumbi, *massae fusae decompositione* ope acidorum volatilium, *acidi superflui remotione* ope evaporationis ad siccitatem, denique *remotione salium formatorum* ope elutionis et quidem aqua acidulata adhibita, exhibetur.

§. 4. Directe silicia nec crystallina neque amorphica cum aqua conjungitur. Cum autem silicia ex *alcalina qua viget solutione* auxilio ammonii chlorati vel neutralisatione solutionis alcalinae cum acido praecipitatur, porro cum ex solutione silicatis kalici, quae

*) Cf. H. Rose ausführliches Handbuch der analytischen Chemie vol. I. pag. 593.

acido quodam superfluo mixta est, ammoniaci ope demittitur, denique cum ex mutua decompositione aquae et silicii fluorici chloratiae oritur, tum in statu nascendi cum aqua conjungitur ita, ut gelatinosum siliciae hydratum existat, quod aliqua ex parte in aqua solvitur. Aquosa siliciae hydratae solutio insipida est et facultate plantarum colores mutandi caret.

SENARMONT observavit, silicium abire in crystalli microscopii auxilio conspicua, quae formam ceterasque crystalli montani proprietates prae se ferunt; hoc enim secundum illius observationem evenit, cum solutio quaedam gelatinosae siliciae in aqua acido carbonico satiata vel in acido muriatico quam maxime diluto sensim sensimque usque ad 200°—300° C. fervere sit *) — Secundum observationem, quam KIRWAN instituit, per 1000 pondera aquae una pars hydrati siliciae solvitur, quae quidem solubilitas *minoris momenti* sumenda est. Exiguo kali natrivi residuo quam maxime augetur siliciae hydrati solubilitas; qua in forma, nempe ut *hypersilicas kalicus seu natricus*, silicia fortasse in multis fontibus fluviisque soluta inest.

Una pars siliciae portiunculam kali continentis, qualis mihi praecipitatione siliciae solutionis dilutae alcalinae auxilio ammonii chlorati et elutione continuata cum aqua apparuit, in 10000 partibus aquae purae solvebatur. Sola cum aqua elutione a residuo kalico silicium equidem liberare non potui.

Hydratum siliciae in 100° C. siccatum non omnem quae inest aquae copiam amittit, quod solummodo accidit in candefactione moderata.

*) Cf. Liebig et Kopp, *Jahresbericht* de anno 1851 pag. 342.

Siliciae combinationes cum aqua sunt pulveres amorphici, albi. Compositio earum alternat ex ratione methodi fabricandi et temperaturae, cui expositae siccatae sunt. Has conjunctiones consilio *combinationes*, non *mixtiones* nominavi; sunt enim eadem merae chemicae conjunctiones, genuina siliciae hydrata aequae atque *argillae* genuina sunt silicatis aluminae hydrata, aequae ac *spumae marinae* genera genuina sunt silicatis magnesia hydrata, aequae ac *ferruginis* genera genuina sunt ferri oxydati hydrata. Causas cur ego haec dixerim has habeo: illae combinationes siliciae cum aqua sub iisdem conditionibus provocatae et in eadem temperatura siccatae continent easdem aquae copias una cum silicia conjunctas. Porro addas, quod hae aquae copiae in temperaturis punctum glaciei fusionis et punctum aquae coctionis superantibus formam solidam in conjunctione cum silicia retinent. Si forte quispiam opposuerit, opalos, nativa genuina siliciae hydrata, jam in temperatura, quae vulgo vigeat, aquam amittere, huic ego contradicam, illam, quam vulgarem dicimus temperaturam, jam talem esse, quali chemica opali combinatio ex parte decomponatur. Et sal mirabile Glauberi et soda crystallisata, ambo merae conjunctiones chemicae salium cum aqua, dilabuntur in temperatura quae vulgo viget.

Hydrata siliciae huc usque cognita haec sunt:

1) *Bisilicas aquae* = $\text{HO}, 2\text{SiO}$ (ab EBELMEN detectus), ex novem partibus aquae et $2 \cdot 15,115 = 30,230$ partibus siliciae constans.

Haec combinatio ex decompositione aetheris silicici (confer §. 7.) eo oritur, quod aqua aëris humidi cum aethere, et cum silicia conjungitur, ex qua con-

junctione ab altera parte alcohol, ab altera parte hydratum siliciae progignitur.

Alcohol evaporatione spontanea disjungitur de hydrato silicico, quod gelatinae instar pellucidae remanet.

Primo tempore hoc hydratum tenerrimum et quam maxime fragile, inter digitos facillime ad pulverem album friabile. Contactu aëris humidi massa sensim sensimque contrahitur et interdum ita indurescit, ut eo vitrum scindi possit; massa illa, crystallisatione omnino carens, splendorem vitreum, et fracturam vitream exhibet. Pondus specificum = 1,77.

In uno experimento EBELMEN e 4,935 grmm. aetheris silicici (C^4H^5O, SiO), quae per 63 dies aëri atmosphaerico humido exponebat, 1,990 grmm. hydrati siliciae obtinuit, quod in centum partes ex 78,2 partibus siliciae et 21,8 partibus aquae constans invenit. Qua ex compositione sequitur formula $HO,2SiO$, qua 77,058 partes siliciae et 22,942 partes aquae postulantur.

Bisilicas aquae liquoribus alcalinis lente solvitur; oleo vitrioli superfuso aquam amittit. Candefactione item aquam perdit et cohaerentiam ipsam. Hoc hydratum merito *opalus facilius* nominari potest; sed ad obtinenda majoris ambitus fragmenta ejusdem concussio quaeque vasium, quibus reservatur, evitetur necesse est (Ebelmen *).

2) *Trisilicas aquae* = $HO,3SiO$ (a DOVERI detectus), ex 9 partibus aquae et $3.15,115 = 45,345$ partibus siliciae constans seu in centum partibus continens:

Siliciae —	83,44 partes
Aquae —	16,56 „
	<hr/> 100,00

*) Cf. annales de chimie et de physique 3me série (fevr. 1846) tome XVI pag. 129; tome XVII pag. 54.

Hoc hydratum praecipitatione siliciae ex solutione alcalina ope acidi hydrochlorici obtentum, post elutionem cum aqua in temperatura ordinaria et in vacuo siccatum, compositionem modo memoratam habet. Eadem combinatio formatur contactu chloreti silicii cum aqua et siccatione praecipitati, aqua abluti in temperatura ordinaria. Trisilicas aquae in lixiviis alcalinis facilius dissolvitur *). Plerique schisti laevigationi inservientes (*Polirschiefer*) compositionem habent trisilicatis aquae. (Secundum Buchholzii analysin.)

3) *Trisilicas cum hexasilicate aquae* = $\text{HO}, 3\text{SiO}$ + $\text{HO}, 6\text{SiO} = \text{HO}, 4\frac{1}{2}\text{SiO}$. *Menilithus*, si hujus analysin a KLAPROTHIO institutam respicimus, huc pertinet. Centum partes hujus mineralis continent:

Siliciae	= 85,5 part.
Aquae	= 11,0 „
Aluminae	= 1,0 „
Ferri oxydati	= 0,5 „
Calciae	= 0,5 „
	<hr/>
	98,5
Jactura	= 1,5
	<hr/>
	100,0.

E formula $\text{HO}, 4\frac{1}{2}\text{SiO}$ computantur 88,3 partes siliciae et 11,7 partes aquae.

4) *Hexasilicas aquae* = $\text{HO}, 6\text{SiO}$.

Componitur ex 90,98 partibus siliciae et 9,02 partibus aquae.

Huic adnumerandae sunt opali varietates, quae vocantur *opali nobiles* (secundum KLAPROTHII analysin ex

*) Cf. *Journ. f. pract. Chemie von Erdmann und Marchand*, vol. 46 pag. 80.

90 partibus siliciae et 10 partibus aquae consistentes), *semiopali*, *opali ignei*, *opali subvirides* (*Chloropale*); posteriores cum variis copiis silicatis oxydi ferri hydratici inquinati sunt; denique *Randanites* temperie, quae vulgo viget (16° C.), siccatus^{*)}.

5) *Enneasilicas aquae* = $\text{HO}, 9 \text{ SiO}$.

Componitur ex 93,8 partibus siliciae et 6,2 partibus aquae.

Hyalithus secundum Buchholzianam analysin partes 92 siliciae et 6,33 partes aquae continet.

6) *Dodecasilicas aquae* = $\text{HO}, 12 \text{ SiO}$.

Ex 95,3 partibus siliciae et 4,7 partibus aquae compositus. *Opali communes* (varietates „*Wachsopal*, *Pechopal*, *Cacholong* dictae) et *Randanites*, in temperatura 100° C. siccatus, hic nominandi sunt.

Notatu dignum est, quod solummodo hydrata siliciae reperiuntur formulis $\text{HO}, 2 \text{ SiO}$ — $\text{HO}, 3 \text{ SiO}$ — $\text{HO}, 4 \frac{1}{2} \text{ SiO}$ — $\text{HO}, 6 \text{ SiO}$ — $\text{HO}, 9 \text{ SiO}$ et $\text{HO}, 12 \text{ SiO}$; sed combinationes intermedias $\text{HO}, 4 \text{ SiO}$ — $\text{HO}, 5 \text{ SiO}$ etc. non minus quam combinationem simplicis formationis HO, SiO existere verisimile est.

§. 5. Siliciae hydratum recenter praecipitatum in acidis tum facilius solvitur, cum in statu nascendi in contactum acidi quam maxime diluti venit. Acida cum silicia conjuncta hac conjunctione *nullo modo neutralisata* exeunt. Combinationes siliciae cum acidis volatilibus solummodo *aqua praesente* existere possunt; evaporatione ad siccitatem acida de silicia sejuncta cum aquae vaporibus tolluntur, dum silicia amorphica hydratica remanet: qua ex re siliciam *basin* esse valde debilem elucet.

^{*)} Conf. Journ. f. pract. Chem. vol. 44, pag. 95; vol. 46, p. 79

§. 6. Silicia cum basibus fortioribus et debilioribus in variis proportionibus conjungi potest; sed in his conjunctionibus, quae *silicates* seu *salia silicica* vocantur, *silicia basium aciem nullo modo hebescit*. Ex harum conjunctionum numero non nisi *silicates alcalini* aqua solvuntur; silicates autem terreno-alcalini, terrarum et oxydorum metallorum graviorum insolubiles sunt in aqua, itemque silicates duplices ex combinatione silicatum alcalinorum cum aliis silicatis nominatis orti.

Formatio silicatum fit aut mutua decompositione *solutionis aquosae silicatis alcalini* et salis respondentis, cujus basin conjungas cum silicia, aut *fusione siliciae* cum basi quadam seu cum hujus basis sale, quod continet acidum volatile.

Silicates fusi refrigeratione post aut massas crystallinas aut amorphicas, pellucidas, coloratas seu coloris expertes formant, quae *vitra silicea* aut *vitra* nominantur.

Silicates silicia abundantes acidis aut non, aut difficilius decomponuntur; illi vero silicates siliciae copias minores continentes acidis facilius afficiuntur, qua affectione silicia in forma gelatinosi hydrati sejungitur.

Acido hydrofluorico omnes silicates decomponuntur, unde gas fluosilicicum formatur.

Ad unum omnes silicates affectionibus ceterorum acidorum *recluduntur* fusione in carbonatibus alcalinis, terreno-alcalinis, seu in oxydo plumbi.

Maxima *terrae nostrae* pars constat e silicia et silicatis; creberrime silicates kali, natri, calcis, magnesia, aluminae, oxyduli ferri et mangani et oxydi ferri reperiuntur.

Inter basica innobilium metallorum oxyda paene nullum est, quin cum silicia native conjunctum reperiatur.

In rerum natura combinationes silicatum cum chloretis, fluoretis et sulphuretis inveniuntur; porro combinationes silicatum cum hydratis, denique salia duplicia silicatum cum carbonatibus, sulfatibus, phosphatibus, boratibus et titanatibus.

§. 7. Cum *oxydo aethylico* silicia in pluribus proportionibus abit in combinationes neutrales, quae oxydo aethylico mono-, bi- et tetrahydratico (alcoholi absoluto, alcoholi mono- et trihydratico) respondent.

Silicates oxydi aethylici oriuntur mutua decompositione chloreti silicii et alcoholis absoluti aut alcoholis usque ad certum gradum hydratici.

Silicas primus, cujus proportio, quod ad oxygenium in silicia et in oxydo aethylico 1: 1 significatur = $\text{C}^1\text{H}^5\text{O}, \text{SiO}$, liquor limpidus, incolor et gustu piperrato, odore jucunde aetherico, pondere specifico = 0,933 in 20°C., cujus punctum ebullitionis in 156°C. apparet; in aqua non solvitur, natatque in ea olei instar.

Affectione aquae longius indurante in primum silicatem oxydi aethylici ille in alcohol et hydratum siliciae (gelatinam silicicam) transformatur. *Densitas reperta* vaporis = 7,32; sin vero posuimus, ut conjunctio constet e $\text{C}^1\text{H}^5\text{O}$, SiO et respondeat uni vaporis volumini, densitas vaporis *computata* = 7,2657.

Silicas secundus continet silicicam et aetherem in proportionem, quae quoad oxygenium in silicia et in oxydo aethylico 2:1 significatur = $\text{C}^1\text{H}^5\text{O}, 2\text{SiO}$. Hic silicas exhibet liquorem minus mobilem, quam primi

silicatis; incolor apparet. molliore odore et gustu; pondus specificum in 24°C. = 1,079; punctum ebullitionis = 360°C; non solvitur aqua, at hac ipsa tardius decomponitur.

Silicatis tertii proportio. quoad oxygenium in silicia et oxygenium in oxydo aethylico significatur 4:1 = $\text{C}^1\text{H}^5\text{O} \cdot 4\text{SiO}$; massam exhibet pellucidam, subflavam, duram, in fractura vitream, quae in 100°C vix emollescit; in altiore temperaturae gradu funditur, ita ut una decomponatur, silicatem secundum in forma vaporis amittit et silicium pulveriformem deponit. Decompositio non ultra 360°C. efficitur.

Hi tres silicates in alcohole et aethere solvuntur. Silicia et cum oxydo amylico conjunctionem init, cujus proportio quoad aequivalentum oxygenii in oxydo amylico et ad aequivalentum oxygenii in silicio 1:1 significatur. Formulâ hujus silicatis = $\text{C}^{10}\text{H}^{11}\text{O} \cdot \text{SiO}$ (EBELMEN)*).

§. 8. Silicia decomponitur:

a) actione *kalii* candescentis; ex hac decompositione oriuntur silicas oxydi kalii et silicio-kalium:

b) actione *carbonis* candescentis auxilio *ferri* aut *cupri* aut *argenti*; silicium de oxygenio sejunctum novas combinationes format cum metallis admixtis;

c) actione *acidi hydrofluorici* in aquam et gas fluo-silicicum;

d) actione *carbonis* candescentis, auxilio *chlori gasiformis* in chloretum silicii et gas oxydi carbonei.

*) Confer. *Annales de chimie et de physique* 3me ser. fevr. 1846, tome XVI pag. 129; tome XVI pag. 54.

Quae cognita habemus de sejunctioe silicii ex silicia praecipue laboribus BERZELII debemus. HENRICUS ROSE, in oratione sua in BERZELII memoriam *) dicit:

„Wenn es BERZELIUS geglückt war, die Metalle der alkalischen Erden mittelst der Voltaschen Säule in Verbindung mit Quecksilber darzustellen, so wollte es ihm dagegen nicht gelingen, auf eine ähnliche Weise das Radical der Kieselerde vom Sauerstoff zu trennen. Um sich nun aber dennoch zu überzeugen, dass die Kieselerde den Erdarten ähnlich zusammengesetzt sei, stellte er eine Reihe von interessanten Versuchen an, um das Radical der Kieselerde mit Metallen, namentlich mit Eisen zu verbinden. Es glückte ihm diess vollkommen, indem er Eisenfeile mit Kohle und Kieselerde mengte und das Gemenge einem starken Gebläsefeuer aussetzte, wodurch er Metallkönige erhielt, die neben Siliciumeisen auch noch Kohle enthielten. Er fand nun, indem er die Menge des Eisens und der Kohle, die letztere freilich auf eine etwas unsichere Weise bestimmte, annähernd den Sauerstoffgehalt der Kieselerde. Es ist übrigens bemerkenswerth, was Berzelius am Ende seiner Abhandlung, die 1810 erschien, äussert. Nachdem er seiner vielen Versuche über den Sauerstoffgehalt der Kieselerde erwähnt, die durchaus nicht ganz übereinstimmende Resultate gegeben hatten, schliesst er nämlich mit den Worten:

*) H. Rose's Gedächtnissrede auf Berzelius, gehalten in der öffentlichen Sitzung der Akademie der Wissenschaften in Berlin, am 3. Juli 1851.

„„Ich halte es übrigens für gleichgültig, den procentischen Gehalt der Kieselerde an Sauerstoff oder an Radical ganz genau zu bestimmen, da ich für jetzt weder einen theoretischen, noch einen praktischen Nutzen von dieser Genauigkeit einsehen kann.““

Wenige Jahre später würde er sich nicht auf diese Weise geäußert haben.“

Cap. II.

De aequivalentis corporum eorundemque formulis.

§. 9. *Pondera mixtionis seu aequivalentia* corporum (aut simplicium aut compositorum) sunt numeri, quibus proportionēs ponderum, in quibus corpora invicem combinantur, exprimuntur, et quidem aut quales sunt aut multiplicati aut divisi numeris simplicibus integrisque.

Aequivalentia chemica eam ob causam nominantur, quod aequum valorem inter se habent chemicum et locum vicarium obtinere possunt, quamquam in plurimis casibus pondera designant quam maxime inter se differentia.

§. 10. *Formula chemica* significationem simplicem qualitatis et quantitatis corporis aut simplicis aut chemice compositi exhibet.

Formula chemica bene electa *simplex, clara, perspicua, non ambigua* sit necesse est, formulisque mathematicis similis, ab iis solummodo eo differens, quod proprietates chemicas corporum apte ac juste exprimat.

His postulatis formulae Berzelianae non perfecte satisfaciunt, saltem quod attinet ad modum designandi oxyda, sulfureta, atomos binarias etc. per puncta, commata in capite formularum, per lineas transversum formulas etc. In chemicis formulis formandis regulae observari sequentes mihi videntur:

1) *Elementorum* formulae ex literis initialibus nominum ipsorum latinorum formandae sunt. *Litera una major* plerumque sufficit, duae literae autem, quarum *prima major secunda minor* in iis casibus tantum ponen-

dae sunt, in quibus plura elementa iisdem literis initialibus scribuntur (e. c. oxygenium = O, sulphur = S, selenium = Se, silicium = Si, stibium = Sb, stannum = Sn etc.).

2) *Ad plura elementorum aequivalentia* in eadem combinatione designanda *coëfficientes*, quibus haec multipla designantur *exponentium mathematicorum instar* formulae elementi juxta ponuntur (e. c. duo aequivalentia ferri = Fe^2 , tria aequivalentia oxygenii = O^3).

3) *Conjunctio primi ordinis*, i. e. duorum elementorum, eo modo designatur, quod elementa conjunctionem ineuntia coëfficientibus suis praedita juxta ponuntur, elemento electropositivo (radicali) praecedente, elemento electronegativo (combustore) postposito (e. c. sesquioxylum ferri = Fe^2O^3 , sesquichloretum ferri = Fe^2Cl^3 , gas hydrogeno-sulphuratum = HS). Signum additionis (+) eam ob causam in his formulis omittitur, quod intima mixtio elementorum exprimitur hac ipsa intima copulatione formularum elementorum.

4) *Ad plura aequivalentia conjunctionis primi ordinis designanda* eorum *coëfficientes* formulae conjunctionis signis parenthesis () non inclusae praecedunt; e. c. duo aequivalentia sesquioxidi ferri = $2 \text{Fe}^2\text{O}^3$.

5) *Combinationes secundi ordinis* i. e. conjunctiones combinationum primi ordinis cum elementis seu cum combinationibus primi ordinis, eo modo designantur, quod formulae elementi, seu combinationum primi ordinis electronegativarum sequuntur formulas combinationum primi ordinis electropositivarum, de his solummodo *commate* sejunctae (e. c. monosulphas kalicus = $\text{KO}.\text{SO}^3$, sesquihydras oxydi ferri = $2 \text{Fe}^2\text{O}^3, 3 \text{HO}$).

6) *Ad plura aequivalenta conjunctionis secundi ordinis designanda* coëfficientes praecedunt formulae lunulis circumscriptae conjunctionis ipsius. E. c. tria aequivalenta monocarbonatis magnesia $\equiv 3 (\text{MgO}, \text{CO}^2)$.

7) *Combinationes tertii ordinis* i. e. conjunctiones combinationum secundi ordinis cum combinationibus primi seu secundi ordinis, ita exscribuntur, ut combinatio inferioris ordinis electropositiva praecedat combinationi inferioris ordinis electronegativae; ambae formulae signo additionis (+) inter se connectuntur. E. c. carbonas calcicus cum tribus carbonatis magnesi aequivalentis $\equiv \text{CaO}, \text{CO}^2 + 3 (\text{MgO}, \text{CO}^2)$.

8) *Connexui combinationum tertii ordinis cum conjunctionibus primi, secundi seu tertii ordinis ad combinationes quarti ordinis* eodem modo signum additionis (+) inservit. E. c. Tetreikosi-hydratum sulphatis aluminico-kalici seu Alumen $\equiv (\text{KO}, \text{SO}^3 + \text{Al}^2\text{O}^3, 3 \text{SO}^3) + 24 \text{HO}$.

9) *Radicalia composita* sunt designanda aut formulis elementariis (e. c. Cyanum $\equiv \text{Cy}$), aut elementorum, quibus formata sunt, inclusione per lunulas, e. c. Cyanum $\equiv (\text{C}^2\text{N})$, aut signo conjunctionis (—) formulis subposito e. c. Cyanum $\equiv \underline{\text{C}^2\text{N}}$. His formulis compositiones ordinum superiorum eodem modo formantur quo formulis elementorum (e. c. acidum hydrocyanicum seu cyanetum hydrogenii $\equiv \text{HCy} \equiv \text{H}(\text{C}^2\text{N}) \equiv \underline{\text{HC}^2\text{N}}$; cyanas oxydi ammonii $\equiv \underline{\text{H}^1\text{NO}}, \underline{\text{C}^2\text{NO}}$ etc.)

10) *Basium cum acidis polybasicis conjunctarum*, quasi basin compositam fingentium formulae, cum coëfficientibus munitae et commatibus separatae lunulis in-

cluduntur et acido polybasico praeponuntur. E. c. *Struvites* = $(\text{H}^4\text{NO}, 2\text{MgO}, \text{HO}), \text{}^c\text{PO}^5 + 12\text{HO}$.

11) Eodem modo *salia illa composita* designantur, quae ex salibus simplicibus *aeque crystallisatis* composita esse videntur, sed variis basibus aut variis acidis aut variis basibus acidisque gaudent. Huic ordini adnumeranda sunt salia, quae *alumina* (*Alaune*) vocantur, plures *carbonates* nativi, denique plurimi *silicates* nativi, e. c. *olivinus* = $(m\text{MgO}, n\text{FeO}), (m+n)\text{SiO} = m(\text{MgO}, \text{SiO}) + n(\text{FeO}, \text{SiO});$
serpentinus = $m(\text{MgO}, 2\text{SiO}) + \text{MgO}, (\text{SiO}, \text{HO})$.

12) In designatione silicatum ex isomorphicis partibus constitutivis compositorum utimur formulis RO et R^2O^3 , primo a NORDENSKIOELD propositis. Formula RO in universum significat unum aequivalentum ex una seu ex pluribus basium fortiorum KO , NaO , LiO , CaO , BaO , SrO , MgO , CeO , LaO , YO , BeO , ZrO , FeO , MnO , CaO , NiO , ZnO , PbO , CuO , CrO formatum; formula R^2O^3 autem unum aequivalentum basis debilioris, formatum ex una seu ex pluribus seu ex omnibus basibus sequentibus: Al^2O^3 , Fe^2O^3 , Mn^2O^3 , Cr^2O^3 .

In illis casibus, ubi silicia partim substituitur acido boracico = BO seu aqua = HO , formulam generalem horum trium oxydorum electronegativorum = $\text{R}\bar{\text{O}}$ sumsi et formulam basium fortiorum in $\text{R}\bar{\text{O}}$ transmutavi. Interdum reperimus silicates, in quibus unum aequivalentum aluminae = Al^2O^3 locum tenet trium aequivalentorum siliciae ($3\text{SiO} = \text{Al}^2\text{O}^3$); tunc formula $\text{R}\bar{\text{O}}$ in universum repraesentat unum aequivalentum oxydi compositi cum componentibus SiO et Al^2O^3 .

Ad hanc regulam exemplo quodam demonstrandam *turmalinum* sumamus. Sunt duae formulae ge-

nerales ad exprimendam *turmalini* compositionem:

$$A = m(\overset{+}{\text{RO}}, 2\bar{\text{RO}}) + n(\text{R}^2\text{O}^3, 3\bar{\text{RO}}) \text{ et}$$

$$B = m(\overset{+}{\text{RO}}, 3\bar{\text{RO}}) + n(\text{R}^2\text{O}^3, 3\bar{\text{RO}}).$$

In his formulis $\overset{+}{\text{RO}}$ significat unum aequivalentum basis compositae cum componentibus KO, NaO, LiO, CaO, MgO, MnO et FeO; R^2O^3 unum aequivalentum basis compositae cum componentibus Al^2O^3 et Fe^2O^3 ; $\bar{\text{RO}}$ unum aequivalentum acidi compositi cum componentibus SiO et BO ($\text{SiO} = 15,1$ et $\text{BO} = 11,6333$); m et n significant numeros simplices integrosque. Oxygenium in $\overset{+}{\text{RO}}$ ad oxygenium in $\bar{\text{RO}}$ quod attinet ad formulam $A = 1:2$, quod ad formulam $B = 1:3$; oxygenium in R^2O^3 ad oxygenium in $\bar{\text{RO}}$, quod attinet ad utramque formulam (A et B) $= 1:1$.

13) In iis conjunctionibus, in quibus *oxygenii* locum *fluorum* seu *chlorum* seu *sulphur* obtinet, nihil impedit, quo minus RO, RCl, RF et RS formula generali RZ (Z = combustor, *Zünder*) substituatur et loco R^2O^3 , R^2Cl^3 , R^2S^3 formula generalis R^2Z^3 , ita quidem, ut et discrimen quod interest inter $\overset{+}{\text{RZ}}$ et $\bar{\text{RZ}}$ exhibatur.

$$\text{E. c. topazius} = \text{Al}^2\text{F}^3, 2\text{SiF} + 6(\text{Al}^2\text{O}^3, 2\text{SiO}) = \text{Al}^2\text{Z}^3, 2\text{SiZ},$$

$$\text{helvinus} = (8\text{BeO}, 7\text{MnO}, 2\frac{1}{2}\text{MnS}, \text{FeO}) + (17\frac{1}{2}\text{SiO}, \text{HO}) = 18\frac{1}{2}(\overset{+}{\text{RZ}}, \bar{\text{RZ}}) = \overset{+}{\text{RZ}}, \bar{\text{RZ}}$$

§. 11. *Regulae corporum aequivalentis formulisque juste constituendis inservientes.*

1) Elementum quoddam, cum unam tantum conjunctionem cum altero tertiove aut in universum cum alio init elemento, *cujus aequivalentum notum est*, tum sumas prioris elementi quantitatem ponderis, quae cum uno aequivalente secundi tertiove aut in universum

1 = alius elementi se conjunxit, utpote *aequivalentum elementi primi*; quippe quam *regulam* nuncupaverim *simplicitatis quoad rationes combinandi*.

Ubi autem ex *isomorphia* conjunctionis elementi cujusdam cum aliis conjunctionibus, quarum *aequivalenta* et formulae *innotescunt*, conjunctiones istas *minus simplicioribus vigere rationibus* concludimus, tum regula simplicitatis non valet. Hujusmodi exceptio- nem habes in oxydo alumii, quod adhuc solum notum est, nempe in alumia ipsa, cujus formula = Al^2O^3 scribenda est; eam ob causam, quod ex ejusdem *isomorphia* cum oxydo ferri = Fe^2O^3 et oxydo chromico = Cr^2O^3 , quae formulae clarae ac distinctae tenendae sunt, sequitur, ut alumia simili quadam formula praedita sit.

2) Ex regula ista simplicitatis derivandum est principium: *ne sumantur minora majorave aequivalenta quam in ipsis conjunctionibus inveniantur*. Contra hanc *regulam*, quam equidem *parcimoniae* nuncupaverim, peccant e. c. ii, qui formulam aquae = H^2O , acidi hydrochlorici = H^2Cl^2 , ammoniaci = H^6N^2 scribunt, peccant eo, quod pro H = 1 idem = 0,5 ponunt etc.; et isti profuse agunt, qui eo, quod siliciae formulam SiO^3 tribuunt, conjunctionum SiO^3 , Si^2O^3 , SiO existentiam ponunt, nihil autem est, unde harum conjunctionum existentia adhuc comprobata sit.

3) Cum elementum, cujus *aequivalentum* exhibendum est, unam tantum cum oxygenio init conjunctionem, tum, ubi hoc oxydum *basicam prae se fert indolem*, sumas *unum* oxygenii *aequivalentum* cum *uno* radicalis *aequivalento* conjunctum esse, ubi autem *merae acidae indolis speciem* prae se fert, statuas ad

unum radicalis aequivalentum *plus quam unum* oxygenii aequivalentum; ubi denique oxyda *ambiguae indolis* sunt, perplures habes causas, quibus aut formula RO aut $RO + x O$ denegatur. Hujus regulae exempla sunt oxydum zinci = ZnO et acidum boracicum = BO^3 . (Quoad formulam acidi boracici, causae sunt, unde formula BO comprobari possit et in his cunctis *isomorphia* respicienda.)

Hanc tertiam regulam equidem nuncupaverim *abundantiae acidorum oxygeniferorum quod ad oxygenium*.

4) Inter oxyda unius ejusdemque metalli basica, illud ex *paribus aequivalentis* formatum est, quod *basis fortior* exit. Haec regula e. c. ad statuenda ferri et mangani aequivalenta inservit.

5) Combinationes ex *paribus aequivalentis* formatae difficilius decomponuntur, quam illae, quae *imparibus aequivalentis* componuntur. Haec regula *intimae combinationis* applicata est in statuenda cupri et hydrargyri aequivalenta.

6) Combinationes in *ceteris rationibus chemicis similes, simili etiam stoechiometrica constitutione* gaudent.

Haec regula *analogiae chemicae* crebrius ad statuenda pondera mixtionum adaptatur e. c. ad confirmanda aequivalenta sulphuris et selenii; bismuthi, stibii et arsenici; cobalti et niccoli etc.

7) Elementa seu combinationes in *iisdem formis crystallinis* apparentes et proprietate praeditae *se invicem supplendi sine formae crystallinae mutatione*, in *has combinationes isomorphicas cum paribus aequivalentis* introducuntur.

Haec regula harmoniae inter formam crystallinam et constitutionem stoechiometricam, *lex isomorphismi (isomorphismi isomerici)*, primo a MITSCHERLICH pronun-

tiata, inservit ad ponendum alumii aequivalentum et ad statuenda alia mixtionum pondera.

In hujus legis applicatione crebro coacti sumus, ut forma crystallina elementorum aut combinationum desistamus (eo, quod forma crystallina horum corporum nondum explorari potuit seu explorata alia inventa est quam exspectata), et ut solummodo isomorphiam combinationum ordinis superioris inquiramus. Hoc e. c. accidit in comparandis combinationibus, quae conjunctione cupri cum oxygenio, sulphure et chloro formantur. Formae crystallinae oxygenii et chlori, adhuc incognitae, similes esse putantur sulphuris formis et quidem eam ob causam, quod oxydulum cupri, semi-sulphuretum cupri et semichloretum hujus metalli eadem forma crystallina induuntur (omnia formis systematicis regularis reperiuntur).

Legis isomorphismi isomerici applicatio ad firmanda aequivalenta corporum simplicium et compositorum essentialiter limitatur existentia *isomorphismi heteromerici*, i. e. similitudinis formae crystallinae inter substantias inaequali stoechiometrica constitutione praeditas. Exempla corporum isomorphismo heteromerico subjectorum sunt permulta, nonnulla tantum eorum protulisse satis erit:

Crystalla *systemati regulari* adnumeranda exhibent: Natrium chloratum = NaCl et chloretum ammonii = H^3NCl , nitras oxydi plumbi = PbO_2NO^5 et nitris oxydi plumbi = PbO_2NO^3 .

Crystalla *ad systema tetragonale* pertinentia praebent: pyrites cupreus (*Kupferkies*) = Cu^2S , Fe^2S^3 et braunites = Mn^2O^3 .

Crystalla *systemati rhombico* adnumeranda formant:

pyrites radiatus (*Strahlkies*) = FeS^2 et pyrites arsenicosus (*Arsenikkies*) = FeAs , FeS^2 ; arragonites = CaO , CO^2 et nitras kalicus = KO , NO^5 ; sulphas natri anhydricus = NaO , SO^3 et hypermanganas baryticus = BaO , Mn^2O^7 ; sulphas kalicus = KO , SO^3 et sulphas ammonicus monohydratus = H^1NO , SO^3 + HO .

Crystalla *systemati monoclinoëdrico* adnumeranda formant: chrysolla (*Borax*) = NaO , 2BO^3 + 10HO et augites = RO , 2SiO (RO = unum aequivalentum baseos ex componentibus CaO , MgO et FeO consistentis).

Crystalla *systemati triclinoëdrico* adnumeranda praebent: labrador = RO , 3SiO + R^2O^3 , 3SiO et anorthites = RO , 2SiO + R^2O^3 , 2SiO .

Crystalla *systemati hexagonali* adnumeranda exhibent: pyrites magneticus (*Magnetkies*) = Fe^7S^8 , pyrites niccolinus ruber (*Rothnickelkies*) = Ni^2As et niccolum monosulphuratum = NiS .

Exempla memoratu digna *isomorphismi heteromerici in uno eodemque minerali (isomorphismus heteromericus HERMANNI)* reperiuntur inter silicates; ex multis exemplis nonnulla. *Turmalinus*, crystallis rhomboëdricis indutus, duplici typo compositionis reperitur, altera series typo $m(\text{R}\ddot{\text{O}}, 2\text{RO}) + n(\text{R}\ddot{\text{O}}, 3\text{RO})$, altera typo $m(\text{R}\ddot{\text{O}}, 2\text{R}\ddot{\text{O}}) + n(\text{R}^2\text{O}^3, 3\text{R}\ddot{\text{O}})$ subjecta est. *Micae*, *orthoklas*, *epidoti*, *pyroxeni*, *amphibolis* species isomorphismo heteromerico non minus subjecta sunt quam turmalini.

Memoratu digna denique sunt isomorphismi heteromerici casus, quibus *mineralia hydratica et anhydrica*, non pseudomorphica, sed re vera *isomorphica*

reperiuntur. Secundum HERMANNI observationem mineralia sequentia isomorphica sunt habenda:

Zirconus = ZrO , SiO et *malaconus* = $6 (\text{ZrO}, \text{SiO}) + \text{HO}$ (ambo crystalli exhibentes systemati tetragonali adnumeranda);

Chrysolithus = RO , SiO et *villarsites* = $4 (\text{RO}, \text{SiO}) + \text{HO}$ (ambo crystalli ad systema rhombicum pertinentia exhibentes);

Leucites = $\text{RO}, 4 \text{SiO} + \text{R}^2\text{O}^3, 4 \text{SiO}$ et *analci- mus* = $(\text{RO}, 4 \text{SiO} + \text{R}^2\text{O}^3, 4 \text{SiO}) + 2 \text{HO}$ (ambo crystalli ad systema regulare pertinentia exhibentes).

SCHEERERI *isomorphismus polymericus* seu compensatio unius aequivalenti magnesia aut baseos cujusdam magnesia isomorphicae per tria aequivalenta aquae et unius aequivalenti oxydi cupri per duo aequivalenta aquae, sine ulla mutatione formae crystallinae, cum experimentis posthac instituendis utpote lex generalis confirmatur, isomorphismo heteromerico adnumerandus est.

9) Secundum *legem a PETIT et DULONG promulgatam aequalium caloris capacitatum quoad aequivalenta elementorum, calorem specificum elementorum inverse proportionalem esse elementorum aequivalentis necesse est, producta autem ex calore specifico uniuscujusque elementi et aequivalente ejusdem elementi sibi aequalia.*

Ex hac lege deduci possit regula ad statuenda elementorum aequivalenta, dum ne lex illa multis exceptionibus subjecta esset. Nam inter 62 elementa hucusque nota, 21 tantum hanc legem sequuntur, nimirum H, N, S, Se, W, Mo, Mn, Te, Bi, Zn, Cd, Sn, Pb, Fe, Co, Ni, Cu, Hg, Pt, Pd, Jr. Producta horum aequivalentorum multiplicatione cum calore specifico

respondente proxima sunt numero 3.2 (si aequivalentum hydrogenii = 1 et calor specificus aquae = 1 ponitur).

Hanc legem non sequuntur:

- a) P, J, As, Sb, Ag et Au. Haec elementa aequivalentis gaudent, *quae ad dimidia reducta* multiplicatione cum calore specifico elementorum respondentium producta praebent aequalia productis ceterorum 21 elementorum. Qua ex re sumendum est, aut aequivalenta phosphori, jodi etc. *duplicem caloris capacitatem* occupare, ac cetera 21 elementa, aut aequivalenta illa ad *dimidia* reduci necesse esse.
- b) *Oxygenii* aequivalento, cum calore oxygenii specifico multiplicato *dimidia tantum pars producti* obtinetur, ac multiplicatis sulphuris etc. aequivalentis cum caloribus specificis respondentibus. Quoniam oxygenii aequivalentum mutare nolumus, caloris capacitatem oxygenii aequivalenti *dimidiam esse* aliorum elementorum, legem Petit-Dulongianam sequentium sumere necesse est.
- c) *Carboni* caloris capacitas quam maxime variabilis reperta est, nempe caloris capacitas *adaman-tis* = $\frac{1}{4}$, *graphitae* = $\frac{1}{3}$, *carbonis* = $\frac{1}{2}$ capacitatis elementorum legi Petit-Dulongianae subsectorum.
- d) *Bromi* caloris capacitas *triplex* est elementorum legem Petit-Dulongianam sequentium.

Quae cum ita sint, hoc temporis momento tantum *regula rationis inter elementorum aequivalenta et eorum caloris capacitatem* eo modo exprimenda est: *Aequivalento ullius elementi cum specifico calore ejusdem elementi multiplicato producta obtineri necesse est, aut*

numero 3,2 proxima aut $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{2}$ aut duplex aut triplex hujus numeri.

9) Ex lege Regnault-Neumanniana aequivalenta conjunctionum, unius ejusdemque stoechiometricae constitutionis, una eademque caloris capacitate vigent. Vel in cunctis conjunctionibus unius ejusdemque stoechiometricae constitutionis calor specificus inverse proportionalis est conjunctionum aequivalentis.

Unde patet, multiplicatione aequivalentorum cum caloribus specificis respondentibus in omnibus stoechiometricae pariter compositis corporibus unum idemque productum i. e. unam eandemque caloris capacitatem produci.

Sic caloris capacitas oxydorum RO, aequivalente hydrogenii = 1 posito paene 5,5 at oxydorum R²O³ = 11 — 14; oxydorum RO² = 6 — 8, chloretorum RCl = 9, chloretorum RCl² = 18 — 19, monocarbonatum = 11, sulphatum = 13.

Caloris capacitas non solum variat cum combustore seu negativo elemento et combinationibus primi ordinis et cum acido in salibus, sed etiam cum aucto minutove uno eodemque negativo elemento, uno eodemque acido.

Quae lex quod commodi praebeat ad conjunctionum aequivalenta examinanda clare apparet. E. c.

<i>Oxydorum</i>	<i>calores</i>	<i>aequi-</i>	<i>caloris</i>
<i>nomina;</i>	<i>specifici;</i>	<i>valenta;</i>	<i>capacitates.</i>

Hydrargyri					
oxydum = HgO	=	0,0518	—	108	— 5,5944
Plumbi					
oxydum = PbO	=	0,0509	—	111,8	— 5,6910
Magnesia = MgO	=	0,2439	—	20	— 4,8780
Glacies = HO	=	0,7200	—	9	— 6,4800

10) Aequivalenta elementaria, quae in aequivalenta composita coëunt, in his ipsis, secundum HERMANNI legem, eandem caloris capacitatem obtinent, quae per se gaudent; igitur caloris capacitas aequivalenti compositi *summa* est caloris capacitarum elementarium aequivalentorum compositum modo dictum formantium *)

E. c. mercurii caloris capacitas = 3,33 (nempe calor specificus mercurii = 0,0333 multiplicatus cum aequivalente mercurii = 100), plus caloris capacitatis oxygenii = 1,8888 (nempe calor oxygenii specificus = 0,2361 multiplicatus cum oxygenii aequivalente = 8) = $3,33 + 1,8888 = 5,2188$ i. e. caloris capacitas oxydi hydrargyri *computata*.

Haec paene congruit cum caloris capacitatem huius oxydi = 5,5944, ut supra.

11) In *salibus neutrale reagentibus* (in chartam exploratoriam indifferentibus) sumendum est *unum baseos aequivalentum et unum acidi aequivalentum*. Haec *neutralitatis regula* in omnibus *monobasicis* quae dicuntur fortioribus acidis inque omnibus fortioribus basibus valet. Cum autem cunctae fortiores bases in uno aequivalente *unum oxygenii aequivalentum* continent, *neutralitatis regula* etiam hoc modo exprimi potest:

Acidi monobasici fortioris aequivalentum ejusdem copia est, quae tantum baseos ad perfectam (charta exploratoria conspicuam) ejusdem neutralisationem requirit, quantum opus est, ut in eadem insit unum oxygenii aequivalentum.

*) Conf. L. Gmelin *Handbuch der Chemie*, ed. IV, vol. I. p. 222.

Ab hac regula recedunt acida, quae *polybasica* vocantur. De eo, num acidum sit monobasicae indolis an polybasicae, praepremis secundum *legem Daltonicam* decernatur, ex qua in conjunctione corporum, quae in pluribus rationibus fiunt, *simplicissimae conjunctionis rationes* postulatur.

Ergo, ubi adhibita *neutralitatis regula* acidorum aequivalentia inveniuntur, quae *singulari quadam numerorum ratione*, quod attinet ad elementaria aequivalentia vigent, ibi a neutralitatis regula recedas. confugasque ad alia acidorum aequivalentia, quae legi Daltonicae melius respondent. E. c. *acidum phosphoricum commune* cum natro tria diversa salia format, quae non respectu aquae contento formulas NaO , $\text{PO}^5 - 2\text{NaO}$, PO^5 et 3NaO , PO^5 exhibent. *Primum sal* chartam heliotropii caeruleam rubefacit, *secundum* caeruleum colorem chartae heliotropii rubefactae tardius restituit, *sal tertium* tam manifestae alcalinae indolis est, ut *ammoniacum* ex conjunctionibus suis expellat. Ex *neutralitatis regula sal secundum unum* aequivalentum acidi phosphorici ad *unum* natri aequivalentum continere possit. Quod acidum cum in hoc casu adhibueris, tum aequivalentum acidi phosphorici esset $= \text{P}^1\text{O}^{2\frac{1}{2}}$; ut hanc inusitatam ac singularem formulam evitemus, istam in acide reagente sale cum NaO conjunctam acidi phosphorici copiam utpote unum aequivalentum sumimus et acidum phosphoricum acidum tribasicum declaramus.

Causa primaria, unde acida polybasica probanda sunt, in earum *capacitate* inest, *arctissimam cum pluribus aquae aequivalentis conjunctionem ineundi*, eandemque reddendi, cum istis loco aquae, et quidem

aequivalentum pro aequivalente, bases admittantur. Acida monobasica autem in statu hydratico nihil aliud continent, nisi *unum* aequivalentum aquae, quae basibus restitui potest. Igitur haec *regula* statui potest:

12) *Ea acidi basisve copia hujus acidi seu basis aequivalentum nominari queat, quae cum uno aquae aequivalente chemice conjungitur, et si plura ejusdem acidi basisve hydrata existunt, quae intimam cum aqua conjunctionem init.* Ab hac autem regula eo magis desistamus necesse est, quo magis corpora cum aqua conjuncta puncto indifferentiae appropinquant; ergo regula ista solummodo in genuinis acidis basibusque genuinis jure meritoque adhiberi potest. In debilioribus aequae acidis ac basibus regula supra (sub 5) exposita, nempe *intimae mixtionis* chemicarum conjunctionum in simplici ratione conjunctorum aequivalentorum adhibeatur.

Sic. e. c. conjunctio e 47,2 partibus kali et 22 partibus acidi carbonici arctior est, quam conjunctio e 47,2 partibus kali et 44 part. acidi carbonici, unde sumimus eandem constare ex uno aequivalente kali et uno aequivalente acidi carbonici, tamen forti alcalica reactione gaudet, quamquam conjunctio acido carbonico magis pollens paene neutrali indole est, ergo ex neutralitatis regula simplicissima esset. —

C a p. III.

De variis siliciae tributis aequivalentis formulisque.

§. 12. *De siliciae et aequivalento et formula per BERZELIUM introductis.*

1) BERZELIUS aequivalentum siliciae = 577,778 posuit (oxygenio = 100 sumto) et formulam siliciae = SiO^3 , potissimum eo commotus, quod minerale illud frequentissimum, quod „*Feldspath*“ vocamus, formula SiO^3 accepta, utpote *silicas aluminico-kalicus neutralis* = $\text{KO}, \text{SiO}^3 + \text{Al}^2\text{O}^3, 3\text{SiO}^3$ designari potest, qua designatione *Feldspath* similitudinem habet cum *sulphate aluminico kalico anhydrico* = $\text{KO}, \text{SO}^3 + \text{Al}^2\text{O}^3, 3\text{SO}^2$. De hac re, BERZELIUS dicit *):

„*Wie bekannt, vermuthen wir aus der Sättigungscapacität der Kieselerde im Feldspath und aus der Analogie dieser so allgemein vorkommenden Verbindung mit Alaun, dass die Kieselerde aus 1 Atom Radical und 3 Atomen Sauerstoff bestehe. Sie könnte aber auch 2 Atome Radical enthalten (also = Si^2O^3 geschrieben werden). Um jedoch das hier Angeführte für nicht mehr gelten zu lassen, als es gelten kann, möge noch Folgendes hinzugefügt werden. Es ist bekannt, dass die Kieselerde mit vielen Basen entsprechende Verbindungen giebt, in denen der Sauerstoff der Kieselerde bloss zweimal so gross ist, als der der Basen; es giebt uns also eigentlich kein anderer Um-*

*) Conf. Berzelius, Jahresbericht über die Fortschritte der physischen Wissenschaften, 1834, 13. Jahrgang p. 173.

stand als die *Allgemeinheit des Feldspaths* einen Wink, welche von diesen Verbindungsweisen als die *neutrale* angesehen werden muss, oder als diejenige, nach welcher die Sauerstoffatome vorzugsweise zu berechnen sind. Es beweist eigentlich das allgemeine Vorkommen des Feldspaths nicht mehr, als dass, im Falle er als *Sesquisilicat* $\equiv KO, 1\frac{1}{2}SiO^2 + Al^2O^3, 4\frac{1}{2}SiO^2$ $\equiv KO, 3SiO^2 + Al^2O^3, 3SiO^2$ zu betrachten wäre, die Masse, woraus er krystallisirt wäre, einen Ueberschuss an Kieselsäure enthalten habe, welche (*sit venio verba*) ein saures Salz bilden konnte.— Auf einer anderen Seite verbindet sich Fluorsilicium mit andern Fluoriden nur in solchen Verhältnissen, wie sie mit einer Zusammensetzung aus 1 Atom Silicium und 2 Atomen Fluor übereinstimmen, und Fluorsilicium entsteht durch gerade Auswechselung der Bestandtheile der Fluorwasserstoffsäure und der Kieselsäure, so dass also dieser Umstand in Verbindung mit dem, dass es Silicate giebt, worin die Kieselerde 4mal den Sauerstoff der Basis enthält auf eine nicht unzweideutige Weise für 1 Atom Radical und 2 Atome Sauerstoff in der Kieselsäure spricht.“

Ex ipsis BERZELII verbis cognoscimus siliciae formulam ab eo esse positam $\equiv SiO^3$, sed non eo consilio, ut eam habeamus absolute firmam omnibus temporibus. Examinemus ergo hoc aequivalentum et hanc formulam, ratione habita regularum modo expositarum ad statuenda aequivalenta.

2) Formula siliciae Berzeliana satisfacit nec *regulae simplicitatis* (§. 11. 1), nec *parcimoniae regulae* (§. 11. 2).

3) Utpote oxydum *ambiguum* regula tertia *minorum oxygenii quantitatum in basium et ejusdem abundantiae in acidis* in silicium adhiberi non potest.

4) Cum silicia *solum et unicum sit silicii oxydum*, etiam regula quarta uti non potest in statuendo siliciae aequivalento.

5) Formula siliciae $= \text{SiO}^3$ contra *regulam intimae mixtionis* (§. 11. 5) formata est, eam ob causam, quod silicia oxydis quam maxime stabilibus adnumeranda est, nimirum illis oxydis, quae „*terrae*“ vocantur; terrae autem sola *carbonis* actione in maximis temperaturae gradibus non decomponuntur. Plurimae terrarum formulam RO acceperunt, sola autem *alumina* formula R^2O^3 gaudet, quoniam excepta est a regula generali ob isomorphismum hujus oxydi cum aliis oxydis formulae R^2O^3 praeditis.

6) Formula siliciae $= \text{SiO}^3$ plane abhorret a *regula analogiae chemicae* (§. 11. 6); nam plurimae combinationes formulae generali RO^3 praeditae proprietatibus pollent quam maxime differentibus ab iis, quae invenimus in silicia. Conferas enim acidorum metallicorum facillime destruentorum seriem: MnO^3 , FeO^3 , CrO^3 , VO^3 , MoO^3 , WoO^3 , AsO^3 , TaO^3 , TeO^3 , OsO^3 , porro seriem acidorum, *mineralium* quae dicuntur, facilius decomponendorum: SO^3 , SeO^3 , ClO^3 , NO^3 , PO^3 , denique seriem oxydorum bases debiliores formantium: AuO^3 , SbO^3 , BiO^3 . Analogia *acidi boracici* $= \text{BO}^3$ cum silicia in auxilio formulae siliciae $= \text{SiO}^3$ afferri non licet, quod formula acidi boracici nondum satis certa posita est. —

7) *Isomorphismus isomericus* (conf. §. 11. 7) formulae SiO^3 favere non videtur, nam oxyda, formula

generali RO^3 gaudentia, quorum forma crystallina nota est, *formas alias quam silicia* exhibent, e. c. *acidum arsenicosum* $= \text{AsO}^3$ (substantia *dimorpha*) crystalli praebet aut *systemati regulari aut rhombico* adnumeranda; eodem modo crystalli *oxydi stibii* $= \text{SbO}^3$ se habent; *silicia* autem, ut supra memoravimus, crystalli *systemati hexagonali* adnumeranda format.

Crystalli ejus mineralis, quod *Feldspath* vocamus, quod attinet ad isomorphismum, cum crystallis aluminis proprio sensu comparari non licet, quia altera *anhydrica*, altera *hydratica* reperiuntur. Cum autem HERMANNI observationes de isomorphismo salium hydratorum et anhydricorum (conf. §. 11. 7) nobis jus tribuunt comparandi alumen et feldspath, horum mineralium comparatione reperimus, quod sal utrumque crystalli diversis systematibus adnumeranda praebet, nempe alumen crystalli *systemati regulari*, feldspath crystalli *systemati monoclinicoëdrico* adnumeranda.

8) Legem *Petit-Dulongianam* (§. 11. 8) adhibere non possumus ad examinandum siliciae aequivalentum, et quidem eam ob causam, quod caloris capacitas *silicii* nondum explorata est. Si hypothetice calorem specificum *silicii* aequalem esse *adamantis* calori specifico ponimus, nimirum $= 0,1469$, secundum REGNAULTI observationes, *caloris capacitas silicii aequivalenti* fit $= 0,1469.21,3456 = 3,1357$, quae capacitas paene congruit cum caloris capacitatibus plurimorum elementorum ($= 3.2$).

9) Lex *Regnault-Neumanniana* formulam siliciae $= \text{SiO}^3$ non probare videtur, quod elucebit e computatione sequente. Calor siliciae specificus (mineralis,

quod *quarzum* vocatur), calore aquae specifico = 1,000 posito, invenitur =

0,1719 (ex observationibus HERMANNI),

0,1790 (e. o. AVOGADRI),

0,1883 (e. NEUMANNI observationibus) et

0,1913 (ex observ. REGNAULTI).

Aequivalentum siliciae, (si formulam SiO^3 accipimus et hydrogenii aequivalentum = 1 ponimus) = 45,3456.

Multiplicatione caloris specifici siliciae cum aequivalente suo invenimus *siliciae caloris capacitatem* = $0,1913 \cdot 45,3456 = 8,6746$ Comparatis caloris capacitibus talium combinationum, qualium formula pertinet ad formulam generalem RO^3 cum caloris capacitate siliciae reperimus majorem differentiam inter illas, quam quae expectari queat. Sunt autem caloris capacitates:

siliciae	= SiO^3	= 0,1913 . 45,3456	= 8,6746,
acidi wolframici	= WO^3	= 0,0798 . 116	= 9,2568,
„ molybdaenici	= MoO^3	= 0,1324 . 70	= 9,2680,
„ arsenicosi	= AsO^3	= 0,1279 . 99	= 12,6621
et oxydi stibii	= SbO^3	= 0,0901 . 153	= 13,7853.

10) HERMANNI *regula* non magis examinando siliciae aequivalente inservire potest, quam lex *Petit-Dulongiana*, quia calor silicii specificus nondum notus est. Sumimus autem hypothetice illius calorem specificum aequalem esse calori specifico adamantis, caloris capacitas silicii = 3,1357 invenitur (conf. §.12. 8).

Cui si addas oxygenii aequivalenti capacitatem caloris, numero 3 multiplicatam, recipies numerum 8,8021 (= $3,1357 + 3 \cdot 1,8888$), id est e *silicii calore specifico (hypothetico) computatam siliciae aequivalenti*

capacitatem caloris. Hic numerus paene congruit cum capacitate aequivalenti siliciae ($= 8,6746$) e calore specifico siliciae computata (conf. §. 12. 9).

11) Regula *neutralitatis* (§. 11. 11) uti non possumus ad statuendum siliciae aequivalentum eam ob causam, quod silicia neque acida nec bases neutralizare potest.

12) Si hydrata siliciae hucusque nota spectamus, ut nobis ad statuendum siliciae aequivalentum inserviant, illa hydratorum series aequivalentum ac formulam Berzelianam confirmare videtur. Cognita autem sunt hydrata siliciae sequentia (conf. §. 4).

I.

II.

Hydratum Ebelmenianum $= \text{HO}, 2\text{SiO} = 3 \text{HO}, 2\text{SiO}^3$

„ Doverianum $= \text{HO}, 3\text{SiO} = \text{HO}, \text{SiO}^3$

„ quod menilithum

vocatur $= \text{HO}, 4\frac{1}{2}\text{SiO} = 2 \text{HO}, 3\text{SiO}^3$

Opalus nobilis $= \text{HO}, 6\text{SiO} = \text{HO}, 2\text{SiO}^3$

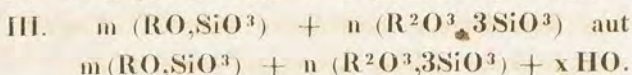
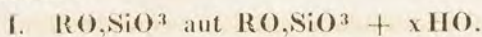
Hyalithus $= \text{HO}, 9\text{SiO} = \text{HO}, 3\text{SiO}^3$

Opalus communis $= \text{HO}, 12\text{SiO} = \text{HO}, 4\text{SiO}^3$

Series secunda, cujus formationi formula SiO^3 inservit, *legi Daltonicae* melius respondet, quam series prima, formulam siliciae SiO continens. Haec series nihilominus ad probandam formulam SiO^3 adhiberi non potest, quia non satis explorata sunt siliciae hydrata, quo efficitur, quod serie prima lacunae inveniuntur. Hydratum Doverianum non ejusmodi est, ut intima aquae combinatio cum silicia appellari possit; siliciae hydrata in universum spectata, facilitatis qua decomponuntur causa, non apta videntur ad statuendum siliciae aequivalentum.

13) Silicatum nativorum perlustratione, quorum

compositio formulis Berzelianis induta est, exiguam copiam talium compositionum conspicimus, qualium partes constitutivae eo modo mixtae sunt, quod oxygenii quantitas siliciae ad oxygenii quantitatem basium, cum silicia conjunctarum (excepta aqua) proportionem 3:1 exprimitur; hae compositiones a BERZELIO *silicates neutrales* denominantur et formulis sequentibus designantur:



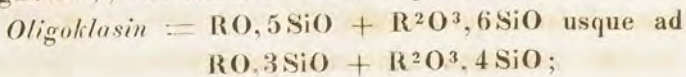
Silicatis neutralibus adnumerandi sunt sequentes:

Eudialytes, *danburites*, *spuma maris*, *agalmatolithus* LYCHNELLI, *cimolites argentieraceus*, *anthosiderites*, *orthoklasin*, *albiten*, *periklinus*, *sanidinus*, *aedelforsiten*, *epistilbites*, *desminus* et *stilbites*.

Silicates neutrales berzelianos sequitur exigua copia *silicatum acidorum* sic dictorum; multitudo ceterorum silicatum utpote *silicates basici* a BERZELIO designata est.

Silicates basici sic dicti creberrime *siliciae liberae* societate reperiuntur, quasi submersi in ea; mihi autem non verisimile esse videtur, silicates basicos sub conditionibus existere, ubi acido silicico satiari occasionem habebant.

Invenimus e. c. in rupibus *graniticis* in societate *quarzi* (siliciae liberae) non solum *orthoklasin* et *albiten*, quorum compositio formula $\text{RO}, 6\text{SiO} + \text{R}^2\text{O}^3, 6\text{SiO}$ exprimi potest (si siliciam formula $\text{SiO} = 15,1$ designamus), sed silicates etiam sequentes:



Micas kaliferas (*Kaliglimmer*) = $m (\text{RO}, 3 \text{SiO}) + n (\text{R}^2\text{O}^3, 3 \text{SiO})$; etc.

Turmalinos = $m (\text{RO}, 2 \text{SiO}) + n (\text{R}^2\text{O}^3, 3 \text{SiO})$ usque ad $m (\text{RO}, 3 \text{SiO}) + n (\text{R}^2\text{O}^3, 3 \text{SiO})$

Amphiboles = $\text{RO}, 2\frac{1}{2} \text{SiO}$ etc.

Talca = $\text{MgO}, 2\frac{1}{2} \text{SiO}$ usque ad $\text{MgO}, 2 \text{SiO}$

Micas magnesiferas (*Talkerdeglimmer*) = $m (\text{RO}, \text{SiO}) + n (\text{R}^2\text{O}^3, 3 \text{SiO})$ usque ad $m (\text{RO}, \text{SiO}) + n (\text{R}^2\text{O}^3, 5 \text{SiO})$

Pistazites = $m (\text{RO}, \text{SiO}) + n (\text{R}^2\text{O}^3, 3 \text{SiO})$

Granatos = $3 (\text{RO}, \text{SiO}) + (\text{R}^2\text{O}^3, 3 \text{SiO})$ aut $3 (\text{RO}, 1\frac{1}{2} \text{SiO}) + (\text{R}^2\text{O}^3, 1\frac{1}{2} \text{SiO})$

Disthenum = $\text{Al}^2\text{O}^3, 2 \text{SiO}$

Topazium = $\text{Al}^2\text{F}^3, 2 \text{SiF} + 6 (\text{Al}^2\text{O}^3, 2 \text{SiO})$

Chloritem = $m (\text{RO}, \text{SiO}) + n (\text{R}^2\text{O}^3, \text{SiO}) + x \text{HO}$
et multos alios silicates, qui minoribus siliciae quantitibus gaudent, quam orthoklasia.

Jure meritoque *disthenum*, *granatos*, imo *chlorites* silicates neutrales esse contenditur potest. Cuncti ceteri silicates, silicia uberiores chloritibus seu saltem granatis, *silicates hypersatiati*, *silicates acidi* nominari queunt.

Ex his praecedentibus argumentis censere me oportet aequivalentum siliciae Berzelianum tollendum esse.

§. 13. De L. GMELINI aequivalente et formula siliciae.

a) In egregio quem edidit L. GMELINUS libro „*Handbuch der Chemie*“, in computandis silicatum formulis exit ex siliciae aequivalente = 31 (hydrogenio = 1 posito, silicio = 15, oxygenio = 8), posuitque ejusdem formulam = SiO^2 , qua in re secutus est vestigia GAUDINI et O. B. KÜHN.

Jam supra (§. 12) diximus, quod BERZELIUS ipse, ob largam in natura rerum copiam generum silicatum, in quibus siliciae oxygenium *duplicem* oxygenii basis partem exhibet, porro ob silicatum existentiam, in quibus silicia *quadruplicem* oxygenii basis partem contineat, denique ob *conjunctionum rationes fluosilicii cum aliis compositionibus fluoricis*, permulta esse momenta exposuit, quibus formula siliciae SiO^2 commendari possit.

Rationem e. c. $\text{RO}:\text{SiO}^2$ vel $\text{R}^2\text{O}^3:3\text{SiO}^2$ inter alia haec praebent:

Wollastonites, pyroxeni, monradites, pikrosminus, pikrophyllus, aphrodites, dioplasis, medulla rupium (Steinmark vom Oemrichsberge), leucites, andesinus, sacharites, analcimus, eudnophites, ledererites, capor-cianites, laumontites, phillipsites, gmelinites, chabasites etc.

Rationem $\text{RO}:2\text{SiO}^2$ vel $\text{R}^2\text{O}^3, 6\text{SiO}^2$ haec exhibent:
Okenites, datolithus, petalithus.

Formulae salium fluosilicium continentium:

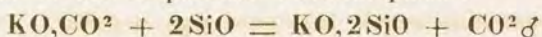
Fluosilicas kalicus = KF, SiF^2 ; fluosilicas natri-cus = NaF, SiF^2 ; fluosilicas baryticus = BaF, SiF^2 ; fluosilicas calcicus = $\text{CaF}, \text{SiF}^2 + 2\text{HO}$.

b) Alia argumenta, quibus GMELINI siliciae aequi-valentum ex sententia variorum chemicorum compro-batur, haec habes:

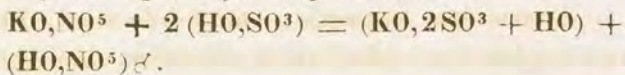
1) Silicia, quantitate carbonatis kalici superflua fusa, tantum acidi carbonici expellit, ut oxygenii quantitas in acido carbonico expulso plane eadem sit, atque oxygenii quantitas in silicia admixta (H. ROSE). Secundum hanc observationem 1 atomus SiO^2 1 at. CO^2 expellit (conf. L. GMELIN *Handb. der Chemie* edit. IV, vol. 2, pag. 355).

In hac quidem observatione ab H. ROSE instituta firmum inesse videtur argumentum ad formulam SiO^2 comprobendam, at ego haec contradicam: Acidum sulphuricum (fortissimum illud acidum) e nitrate kalico acidum nitricum *difficile tantum atque imperfecte* expellit, si *unum* ejusdem aequivalentum in unum nitratis kalici aequivalentum efficacitatem suam exercet (secundum MITSCHERLICH in 220°C . demum); decompositio autem nitratis kalici jam in coctionis puncto acidi nitrici ultrave paucos gradus *facile atque perfecte* fit, cum *duo* monohydrati acidi sulphurici aequivalenta in unum nitratis kalici aequivalentum vim suam exercent.

Inde apparet, decompositionis processum in fusione carbonatis kalici cum non sufficientibus siliciae quantitibus et hac aequatione exscribi posse:



per analogiam decompositionis nitratis kalici acidi sulphurici hydrati ope, cujus aequatio haec est:



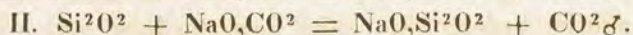
2) *Silicium*, quia similitudinem habet cum *carbono*, *silicia cum acido carbonico acidove titanico et oxydo stanni*, inde apte actum erit, siliciae similem quandam oxydis tribus modo nominatis formulam tribuere. Quamvis hanc similitudinem ingenue agnoscamus, attamen negare non possumus, quin silicia etiam similitudine quadam gaudeat cum *alumia* et quin eadem *aquae* simillima sit. Inde non mirum, quod ejusdem formula aequo jure Si^2O^3 et SiO designari possit. Silicia in crystalla abit, quae ad idem systema pertinent ac aluminae et aquae crystalla, at acidum titanicum, utpote *anatas* et *rutilus* in crystalla tetra-

gonalis systematis, utpote *Brookites* in formas rhombici systematis et oxydum stannicum, ut lapis stannicus (*Zinnstein*) in formas tetragonalis systematis.

Alumia kali conjuncta crystalli exhibet, quorum compositio $= \text{K} \text{O}, \text{Al}^2 \text{O}^3 + 2 \text{H} \text{O}$.

Unum alumiae aequivalentum $= \text{Al}^2 \text{O}^3$ ($= 51,4$ partibus pondo) superfluo carbonate natrico fusum summo cum vigore paullulum plus quam unum acidi carbonici aequivalentum ($= 22$ partes pondo) expellit.

Eodem jure, quo duo alumii aequivalenta in uno aequivalente *alumiae* sumsimus ad eam oxygenii quantitatem, quae uni acidi carbonici aequivalente occurrit, eodem jure etiam in silicia duo silicii aequivalenta ad eam oxygenii quantitatem, quae uni acidi carbonici aequivalente occurrit, statuere possumus, potissimum tum, cum aliis causis tale quid non negatur.



Alumia cum magnesia, cum oxydo zinci, beryllia, cum oxydulo ferri salia format, silicatis simillima; e. c. spinellum $= \text{MgO}, \text{Al}^2 \text{O}^3$, gahnitem $= \text{ZnO}, \text{Al}^2 \text{O}^3$, chrysoberyllum $= \text{BeO}, \text{Al}^2 \text{O}^3$, hereynitem $= \text{FeO}, \text{Al}^2 \text{O}^3$. —

Aquae, quod ad chemicas proprietates, similitudo quaedam est cum silicia et ob *neutralem earum reactionem* et ob multitudinem rationum, sub quibus conjunctiones inire possunt cum basibus.

3) *Silicates crebro cum carbonatibus titanatibusve conjunctiones ineunt* e. c. in titanite ($=$ titanus calcicus cum silicate calcico), cancrinite (silicas aluminiconatricus cum carbonate calcico); unde forte quispiam iisdem stoechiometricis formulis significari posse et

silicium et acidum titanicum et carbonicum, concluderit.

Haec autem concludendi ratio, quae eodem jure quod ad combinationes silicatum cum *sulfatibus*, cum *aluminatibus*, *hydratis*re adhiberi possit, falsa est; nam ex conjunctionibus silicatum cum carbonatibus seu cum titanatibus siliciae formula derivanda esset $= \text{SiO}^2$, ex combinationibus silicatum cum sulfatibus formula SiO^3 , cum aluminatibus formula Si^2O^3 , denique cum hydratis formula SiO . Silicia autem una tantum formula significari potest.

4) Posita formula SiO^2 silicia legi Regnault-Neumannianae de caloris capacitate combinationum chemicarum bene subsumitur.

Combinations; calores aequivalendi; caloris specifici; lenta; capacitates.

Silicia	$= \text{SiO}^2 =$	0,1913	—	30,23	—	5,783
acidum						
titanicum	$= \text{TiO}^2 =$	0,1703	—	41	—	6,9823
oxydum						
stanni	$= \text{SnO}^2 =$	0,0933	—	74	—	6,9042
Bioxydum						
manganicum	$= \text{MnO}^2 =$	0,191	—	43,6	—	8,3276

Hi quidem numeri capacitatem caloris exprimentes non ejusmodi sunt, ut ex iis perfectus consensus cum lege Regnault-Neumanniana statui possit, sed melius respondent legi isti ac si formulam siliciae posueris $= \text{SiO}^3$.

5) Siliciae hydrata egregie respondent formulae SiO^2 : Hydratum Ebelmenianum $= \text{H}_2\text{O}, \text{SiO}^2$; hydratum Doverianum $= \text{H}_2\text{O}, \frac{1}{2}\text{SiO}^2$; menilitus $= \text{H}_2\text{O}, 2\text{SiO}^2$;

opalus nobilis = $\text{HO},3\text{SiO}^2$; hyalithus = $\text{HO},4\frac{1}{2}\text{SiO}^2$ et opalus communis = $\text{HO},6\text{SiO}$.

Hic solummodo formula $\text{HO},5\text{SiO}^2$ deest, quae fortasse ex opali varietate quadam indagari possit.

6) Aequivalentum chloreti silicii duobus voluminibus repraesentatur, cum formulam chloreti silicii = SiCl^2 , ergo formulam siliciae = SiO^2 posueris; chloretum silicii tum legi generali, quod attinet ad volumina vaporum conjunctionum, se submittit (*Cahours*).

Ponamus ut quatuor volumina chlori gasiformis et 2 volumina vaporum silicii coierint in duo volumina vaporum chloreti silicii, tum subtractis 4.2,4543 pondo partibus chlori gasiformis de 2.5,939 pondo partibus vaporum chloreti silicii, differentiam habes 2,0608 pondo partium vaporum silicii = 1 aequiv. silicii, si 2.2,4543 pondo partes chlori = 1 aequiv. chlori ponuntur. Si chlori aequivalentum = 35,5 ($\text{H} = 1$) ponamus, tum efficitur aequivalentum silicii = $14,904 = \left(\frac{35,5 \cdot 2,0608}{4,9086}\right)$, chloreti silicii = $\text{SiCl}^2 = 85,904$, siliciae = $\text{SiO}^2 = 30,904$.

c) Formula SiO^2 his improbatur:

- 1) eadem neque respondet *regulae simplicitatis*;
- 2) neque *parsimoniae*;
- 3) silicia, cum meri acidi indolem non habeat, cum potius simile quid habeat *aquae* et *aluminae*, cum combinatio sit *ambigua*, tum ex formula SiO^2 falsa quaedam de siliciae natura excitari possunt eam ob causam, quod formula ista memoria genuinorum acidorum ut CO^2 , SO^2 , SeO^2 moveri possit.

4) Porro repugnat *regulae intimae conjunctionis*

combinationum chemicarum in simplicioribus aequivalentorum rationibus formatorum.

5) Denique aequae hac formula ac Berzeliana SiO^3 cogimur, ut formationem *silicatum basicorum* (non satorum) statuamus in iis conditionibus, quibus silicates *neutrales* (satiati), imo silicates *acidi* (hypersatiati) oriri possint. Ne repetamus illa, quae supra (in §. 12. 13) memoravimus, *granatum*, *pistazitem* et *disthenum* in memoriam revocasse sufficiet.

Posita siliciae formula SiO^2 secundum Gmelinum *granatus* significatur $3\text{RO}, \text{R}^2\text{O}^3 + 3\text{SiO}^2$, *pistazites* in plurimis casibus $= 3\text{RO}, 2\text{R}^2\text{O}^3 + 4\text{SiO}^2$, *disthenum* $= \text{Al}^2\text{O}^3, \text{SiO}^2$; in his tribus silicatis tantum siliciae deest, quantum opus est, ut *neutralis conjunctio* RO, SiO^2 seu $\text{R}^2\text{O}^3, 3\text{SiO}^2$ restituatur. His acidi quid ad neutralitatem deesse verisimile non est, quia granatos, pistazites et disthenum in societate *quarzi liberi*, e. c. in rupibus graniticis saepius inveniuntur.

Quae cum ita sint, etiam hanc formulam, non denegatis, quae commoda praebeat, repudiandam esse censemus.

§. 14. *Quaedam de formula Si^2O^3 .*

BERZELIUS in ephemeridibus de anno 1834 pag. 172 quod ad hanc formulam spectat, cum analyses communicat granati varietatum quarundam a DE KOBELL institutas, haec dicit: „*Es möchte hier nicht unpassend sein, einer Speculation zu erwähnen, in Betreff der Form des Granats, die bekanntlich eine von denen ist, die den Verbindungen angehört, deren Zusammensetzung durch $\text{RO}, \text{R}^2\text{O}^3$ ausgedrückt werden kann* (granatus enim in crystallis abit systematis regularis; crystalli ejusdem systematis praebent etiam: spinellus

$= \text{MgO}, \text{Al}^2\text{O}^3$, pleonastus $= \text{MgO}, \text{Fe}^2\text{O}^3$, gahnites seu automolites $= \text{ZnO}, \text{Al}^2\text{O}^3$, kreittonites $\text{RO}, \text{R}^2\text{O}^3$, in quo $\text{RO} = \text{ZnO}, \text{FeO}, \text{MgO}, \text{MnO}$ et $\text{R}^2\text{O}^3 = \text{Al}^2\text{O}^3, \text{Fe}^2\text{O}^3$; franklinites $= \text{ZnO}, \text{Fe}^2\text{O}^3$; magnes $= \text{FeO}, \text{Fe}^2\text{O}^3$; hercynites $= \text{FeO}, \text{Al}^2\text{O}^3$, et minerale quod vocatur „Chrom-eisenerz“ $= \text{RO}, \text{R}^2\text{O}^3$, in quo $\text{RO} = \text{FeO}$, cum aliqua parte MgO et $\text{R}^2\text{O}^3 = \text{Cr}^2\text{O}^3$ cum aliqua parte Al^2O^3 . *Wir wollen einmal annehmen, die Kieselerde hätte die Zusammensetzung Si^2O^3 und wir schrieben demnach die Formel des Granats $= 3 \text{CaO}, \text{Si}^2\text{O}^3 + \text{Al}^2\text{O}^3, \text{Si}^2\text{O}^3$. In dieser Formel haben wir dann 9 Atome Radical und 12 Atome Sauerstoff, was wieder 3 $(\text{RO}, \text{R}^2\text{O}^3)$ oder 3 Atome Radical auf 4 Atome Sauerstoff giebt. Die Formel des Granats müsste dann $\text{CaO}, \text{Al}^2\text{O}^3 + 2(\text{CaO}, \text{Si}^2\text{O}^3)$ geschrieben werden. Ob in dieser Betrachtung etwas liege oder nichts, möge eine erweiterte Erfahrung ausweisen.“*

Ex mea sententia non bene actum esset, siliciae formulam, ut similitudinem, quam habet cum alumia, exprimamus, in formulam Si^2O^3 immutasse. Haec quidem significatio commendatur *forma siliciae crystallina*, porro *capacitate alumiae, siliciam in silicatis quibusdam ex parte restituendi* (e. c. in pyroxenis et amphibolibus aluminiferis); sed improbatur eo, quod, ea accepta, regulae *simplicitatis parsimoniaeque* negligantur; exigua *siliciae basicitate* etiam denegatur formula, quae corporum mentionem facit, quae indole quidem debili sed *manifesta basica* vigent.

Cum lege *Regnault-Neumanniana* formula Si^2O^3 plane non congruit.

§. 15. De DUMASII formula *Siliciae* $= \text{SiO}$.

a) DUMASIUS e pondere vaporum chlorreti silicii spe-

cifico = 5,939 computavit silicii aequivalentum = 7,452, siliciae mixtionis pondus = 15,452 formulamque siliciae = SiO posuit. Perillustris ille chemicus putavit, in uno volumine vaporis chloreti silicii duo volumina chlori gasiformis cum uno volumine vaporis silicii conjuncta inesse, et e pondere specifico vaporum chloreti silicii, ab eo explorato, pondus specificum vaporum silicii eo modo computavit, quod pondus specificum duplex chlori, nempe $2 \cdot 2,4543 = 4,9086$ a pondere specifico chloreti silicii vaporis subtraxit. Et differentia reperta = $5,9390 - 4,9086 = 1,0304$, aut e pondere vaporum silicii specifico aequivalentum silicii invenit proportionem sequenti:

$$2 \cdot 2,4543 : 35,5 = 1,0304 : x$$

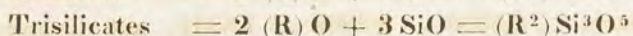
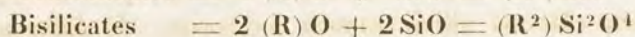
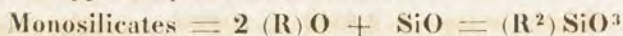
$$\text{et } x = \frac{35,5 \cdot 1,0304}{4,9086} = 7,452 = \text{aequivalento silicii,}$$

(hydrogenii aeq. = 1). In hac proportionem duo volumina chlori gasiformis = 1 aequivalentum chlori sumta sunt.

b) EBELMEN Dumasium secutus est in eo, quod silicii aequivalentum = 7,452 aut potius = 7,115 (secundum indagationem accuratiorem Pelouzzii) accepit, aequivalentum siliciae = 15,115 et formulam ejusdem = SiO posuit, potissimum eam ob causam, quod combinationes siliciae cum aethere detegit formulis $\text{C}^1\text{H}^5\text{O}$, $\text{SiO} - \text{C}^1\text{H}^5\text{O}$, 2SiO et $\text{C}^1\text{H}^5\text{O}$, 4SiO praeditis, inter quas combinationes prima utpote *combinatio neutralis* se habuit (confer. §. 7).

c) Etiam illustris LAURENT siliciam formula = SiO designandam esse censuit novasque silicatum formulas in medium protulit, quibus *naturam polybasicam siliciae* aut ejusdem proprietatem simul cum pluribus ba-

sibus sese conjungendi exprimere voluit Porro, omnia metallorum oxyda, quae facultate cum silicia sese conjungendi gaudent, ex *paribus aequivalentis* metalli et oxygenii composita et inter se partim isomorphica esse putavit. (E. c. *oxydum* ferri simili formula designavit ac *oxydulum* ferri, in altera combinatione aliud autem aequivalentum ferri sumsit atque in altera). Omnes silicates typis sequentibus summisit



Tetrasilicates etc. usque ad Octosilicates.

Unicuique typo alios subtypos silicatum hydraticorum et basicorum adjunxit, formulis $n \text{RO} + 2 (\text{R}) \text{O} + n \text{SiO}$ designatos.

Quamquam negare non possum, quin permultis silicatis oxygenii quantitas in basibus $\text{RO} + \text{R}^2 \text{O}^3$ aequalis aut paene aequalis sit oxygenii quantitati in silicia (e. c. in epidotis, vesuvianis, granatis), attamen eum plane detorsisse aequivalenti notionem puto, qui duo diversa aequivalenta in uno eodemque elemento statuerit.

d) BERZELIUS in suis *formulis silicatum mineralogicis* seu *empiricis* sic dictis tacitus quasi formulam siliciae $= \text{SiO} = \frac{\text{SiO}^3}{3}$ et formulam aluminae $= \text{AlO} = \frac{\text{Al}^2 \text{O}^3}{3}$ accepit.

E. c. *mesotypi natrici* formulam exscripsit $= \text{NS}^3 + 3 \text{AS} + 2 \text{Aq}$;

nihil aliud autem significat illa nisi $\text{NaO}, 3 \text{SiO} + 3 (\text{AlO}, \text{SiO}) + 2 \text{HO} = (\text{NaO}, 3 \text{SiO} + \text{Al}^2 \text{O}^3, 3 \text{SiO}) + 2 \text{HO}$.

Porro *analytici* formula Berzeliana chemica $= 3 \text{NaO}, 2\text{SiO}^3 + 3(\text{Al}^2\text{O}^3, 2\text{SiO}^3) + 6\text{HO}$, mineralogica aut empirica sic dicta

$= \text{NS}^2 + 3\text{AS}^2 + 2\text{HO}$, quae formulae eadem significant ac $\text{NaO}, 2\text{SiO} + 3(\text{Al}^2\text{O}^3, 2\text{SiO}) + 2\text{HO}$.

$= \text{NaO}, 2\text{SiO} + \text{Al}^2\text{O}^3, 6\text{SiO} + 2\text{HO}$.

$= (\text{NaO}, 4\text{SiO} + \text{Al}^2\text{O}^3, 4\text{SiO}) + 2\text{HO}$.

BERZELIUS has designationes unius ejusdemque objecti diversas non introduxisset, nisi acceptis formulis SiO et AlO , proportiones fore simpliciores intellexisset. Cum autem mineralogia et chemia inter se intime conjunctae sunt, in his tractandis literis ad designanda mineralia uno eodemque designationis modo uti, melius actum esset.

e) *Aliae rationes ad siliciae formulam $= \text{SiO}$ confirmandam haec sunt:*

1) Formula SiO *regulae simplicitatis* in proportionibus chemicis bene respondet (§. 11. a).

2) Regula *parsimoniae* illa non violatur (§. 11. b).

3) Melius apta est ad *oxydi ambigui* designationem, quam ulla alia formula, quia paribus aequivalentis elementorum electropositivorum ac electronegativorum aequilibrium ac neutralitas eorum clare ad oculos demonstratur. Si quis opposuerit, formulam SiO ob similitudinem cum formulis basium fortiorum RO permutari posse cum his basibus, illi contradicam, quod haec permutatio tum fieri non potest, cum siliciae formula in silicatum formulis basium formulis *postponitur*; ex qua positione clare elucebit, siliciam oxydum esse electronegativum.

4) Formula SiO contra *regulam intimae mixtionis*

compositionum chemicarum proportionibus simplicibus conjunctis (§. 11. c.) non peccat.

5. Haec formula *similitudinem siliciae cum aqua* in memoriam revocat. Praeter *similitudinem formae crystallinae* et praeter *neutralitatem* (cf. §. 13. sub b. 2.) silicia pluribus aliis cum aqua analogiis gaudet. Fuit quondam silicia solvens ac *menstruum igneofluidum terrarum* simulatque *aqua menstruum salium in temperatura ordinaria*. Series silicatum nativorum, seriei numerorum naturalium respondens, juxtaponi potest seriei hydratorum eadem ratione formatorum:

Silicates.

Hydrata.

- | | |
|---|---|
| a) RO, SiO; e. c. olivinus =
m (MgO, SiO) + n (FeO, SiO) | a) RO, HO; e. c. Brucites =
MgO, HO |
| b) R ² O ³ , 2 SiO; e. c. disthenus
= Al ² O ³ , 2 SiO | b) R ² O ³ , 2 HO; e. c. bihydraz fer-
ricus = Fe ² O ³ , 2 HO |
| c) R ² O ³ , 3 SiO; e. c. xenolithus
= Al ² O ³ , 3 SiO | c) R ² O ³ , 3 HO; e. c. hydrargylli-
tes = Al ² O ³ , 3 HO |
| d) RO, 4 SiO + R ² O ³ , 4 SiO; e. c.
leucites. | d) RZ, 4 HO; e. c. chloretum natrii
hydraticum = NaCl, 4 HO |
| e) RO, 5 SiO; e. c. pentasilicas na-
tricus = NaO, 5 SiO | e) RO, 5 HO; e. c. pentahydraz ka-
licus crystallisatus = KO, 5 HO |
| f) RO, 6 SiO + R ² O ³ , 6 SiO; e. c.
orthoklasia. | f) RZ, 6 HO; e. c. Baryum sulphu-
raturum cum aqua, Chloretum
strontii c.aq.; chloretum calcii
c. aqua.
(BaS, 6HO; SrO, 6HO; CaCl, 6HO) |
| g) RO, 7 SiO + R ² O ³ , 7 SiO; e. c.
albites de Chesterfield. | g) RO, 7 HO? |
| h) RO, 8 SiO + R ² O ³ , 8 SiO; e. c.
petalites. | h) RO, 8 HO? |
| i) R ² O ³ , 9 SiO; e. c. agalmatholi-
thus = Al ² O ³ , 9 SiO | i) RO, 9 HO; e. c. Hydraturum stron-
tiana = SrO, 9 HO |
| k) RO, 10 SiO + R ² O ³ , 10 SiO;
e. c. certi obsidiani; etc. etc. | k) RO, 10 HO; e. c. Hydraturum ba-
rytae = BaO, 10HO. |

Et in hac tabula et in expositione silicatum quorundam nativorum infra exhibenda nos sententiam secuti sumus, silicates duplices habendos esse pro combinationibus silicatum simplicium *pari modo silicia satiatorum*, qua quidem in expositione *Berzelianam* de *capacitate saturitatis theoriam* non respeximus. Tribuimus e. c. ibi, ubi unum aequivalentum kali = KO cum uno aequivalente alumiae = Al^2O^3 et cum duodecim aequivalentis siliciae = 12SiO conjuncta erant, 6 aequivalenta SiO uni aequivalento kali *totidemque* uni alumiae aequivalento, ita ut formula $\text{KO}, 6 \text{SiO} + \text{Al}^2\text{O}^3, 6 \text{SiO}$ formata sit. Ex *BERZELII* theoria de saturitatis capacitate utrique basi tantum siliciae tribuendum esset, ut formarentur silicates simplices, in quibus una eademque proportio quod ad siliciae oxygenium et ad oxygenium basis in utroque simplici silicate statueretur. Secundum haec modo exposita formula modo dicta sic exscribenda esset: $\text{KO}, 3 \text{SiO} + \text{Al}^2\text{O}^3, 9 \text{SiO}$. Quamquam haec formulas scribendi ratio significatur utpote *rationalis*, attamen totus in eo sum, ut formulas illas, utpote *empiricas* significatas exscriberem, et quidem eam ob causam, quoniam e vestigio conspicuum fit, *quam forte satiatius quispiam sit silicas cum silicia*. Ubi autem aequalis distributio siliciae aequivalentorum, quod ad bases, numeris fractis significanda esset, ibi alteri basi, plerumve basi R^2O^3 , unum duove aequivalenta siliciae amplius attribui atque alteri. *BERZELIUS* in ratione formulas scribendi, quod jam supra (§. 15. d.) monuimus, inde exit, quod in Al^2O^3 seu in generali formula = R^2O^3 tria basis aequivalenta insint; nos autem formulam R^2O^3 aequalem uni aequi-

valento sumsimus, nominamusque e. c. spinellum *monoaluminatē magnesiae* = $\text{MgO}, \text{Al}^2\text{O}^3$.

Ex analogia, quae est inter siliciam et aquam, facile concludi potest, aequē silicates existere in rerum natura, qui alteram siliciae partem *firmitus* conjunctam quam alteram contineant, atque hydrata salium reperiri, in quibus *aqua plus minusve firme conjuncta* insit.

Inconstante plurium crystallographice bene distinctorum silicatum compositione e. c. *turmalinorum, oligoklasium* aliorumque mineralium, satis superque significatur, quod in iisdem praeter siliciam in compositionibus $m(\text{RO}, y\text{SiO}) + n(\text{R}^2\text{O}^3, z\text{SiO})$ inventam alia *minus intime conjuncta silicia* reperiatur, cujus combinationis ratio = $m(\text{RO}, y\text{SiO}) + n(\text{R}^2\text{O}^3, z\text{SiO}) + x\text{SiO}$. Literae m, n, x intra certos quosdam terminos fluctuantēs coërcentur, qua autem in fluctuatione non mineralis species, ne forma quidem speciei mutatur.

E. c. Micae magnesiferae ex analysibus adhuc editis tribus generalibus formulis significandae sunt:

$$\text{A} = m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO});$$

$$\text{B} = m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, 4\text{SiO});$$

$$\text{C} = m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, 5\text{SiO}).$$

Hae tres formulae conjunctae hanc formulam generalem exhibent:

$$\text{D} = m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO} + x\text{SiO}); \text{ in qua} \\ \text{formula } x = 0 \text{ aut } 1 \text{ aut } 2.$$

Quae literis $x\text{SiO}$ designantur, dum simili modo conjuncta esse videntur, quo *crystallisationis aqua* in societate cum *aqua hydratico* in basium hydratis (e. c. in hydrato kalico = $\text{KO}, \text{HO} + 4\text{Aq}$). Formula **D** tum etiam exprimi possit:

$$\text{D} = m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO}) + nx\text{SiO}.$$

6) In computandis silicatum formulis secundum analyses quae existunt — dico enim accuratas et satis distinctas analyses — formula SiO *subtilitatem duplicem* praebet, quam formula SiO^2 et *triplicem* quam formula SiO^3 . Hoc evenit eo, quod aequivalentum siliciae $= \text{SiO}$ *dimidiam* aequivalenti siliciae $= \text{SiO}^2$ et *tertiam partem* aequivalenti siliciae $= \text{SiO}^3$ exhibet. Quotum autem, divisione partium centesimalium conjunctionis ejusdam chemicae per aequivalentum siliciae $= \text{SiO}$ inventi, quibus proportio aequivalentorum inter se conjectorum significatur, *ter majores* reperiuntur, quam adhibito siliciae aequivalento $= \text{SiO}^3$ et *bis majores*, quam adhibito siliciae aequivalento $= \text{SiO}^2$.

Ponamus e. c., ut *quotus* siliciae, divisione partium centesimalium siliciae per aequivalentum siliciae $= \text{SiO}^3$ obtentus, aequalis sit $10\frac{1}{2}$, tum aequo jure hoc dimidium aequivalentum siliciae aut negligere aut aequale uni aequivalento ponere possimus. Aequivalento siliciae $= \text{SiO}$ in hac divisione adhibito quotum siliciae $= 3 \cdot 10\frac{1}{2} = 31\frac{1}{2}$ reperimus; ex quo numero aequo jure dimidium aequivalentum siliciae aut negligere aut aequale uni aequivalento sumere possimus. Sed aut accepto pro uno aequivalento aut neglecto aequivalento dimidio, in primo casu (ubi aequivalento siliciae $= \text{SiO}^3$ usi sumus) vitium *ter majus* est, quam in secundo casu (ubi aequivalento siliciae $= \text{SiO}$ usi sumus). Simili computatione nobis persuadere possumus, subtilitatem *duplicem* esse in formulis silicatum, qui formula SiO gaudent, quam in illis, quibus formula SiO^2 usi sumus.

7) In multis silicatis suppositionem unius aequivalenti siliciae $= \text{SiO}$ per unum aequivalentum aquae $= \text{HO}$ observamus. Hoc accidit e. c. in multis varie-

tatibus serpentini, in nonnullis augitis et amphibolibus, aliisque silicatis. Inter exempla frequentiora marmolithum eligamus.

I. *Marmolithus*, prope Hoboken in New-Jersey repertus, secundum GARRETTII analysin continet in centum partibus:

	part. cent.	part. oxygen.			
MgO	= 42,23	= 16,892	{	= 17,176 \vec{RO} = 1	= 3 = 3 \vec{RO} ;
FeO	= 1,28	= 0,284			
Al ² O ³	= 0,66	= 0,308	{	= 22,729 \vec{RO} = 1,323	= 3,969 = 4 \vec{RO} ;
SiO	= 42,32	= 22,421			
HO	= $\frac{13,80}{100,29}$	= 12,267		= 12,267 HO = 0,714	= 2,142 = 2 HO.

Formula hujus marmolithi

$$= 3\vec{RO}, 4\vec{RO} + 2HO = 2(\vec{RO}, 2RO) + (\vec{RO}, 2HO).$$

II. *Marmolithus*, prope Orjervfi in Finlandia repertus, secundum HERMANNI analysin continet in centum partibus:

	part. cent.	part. oxygen.			
MgO	= 42,40	= 16,96	{	= 17,36 RO = 1	= 5 = 5 RO;
FeO	= 1,80	= 0,40			
SiO	= 40,00	= 21,19		= 21,19 SiO = 1,222	= 6,11 = 6 SiO;
HO	= $\frac{15,80}{100,00}$	= 19,04		= 14,04 HO = 0,808	= 4,04 = 4 HO.

Formula hujus marmolithi

$$= 5\vec{RO}, 6\vec{SiO} + 4HO = 3(\vec{RO}, 2\vec{SiO}) + 2(\vec{RO}, 2HO).$$

Ad comparandas ambarum marmolithi modificationum formulas

$$I. = 2(\vec{RO}, 2\vec{RO}) + (\vec{RO}, 2HO) \text{ et}$$

II. = 3(\vec{RO} , 2 \vec{RO}) + 2(\vec{RO} , 2HO) multiplicatione cum numero 5 aut 3 illas transmutare possumus in sequentes:

$$I. 10(\vec{RO}, 2\vec{RO}) + 5(\vec{RO}, 2HO);$$

$$II. 9(\vec{RO}, 2\vec{RO}) + 6(\vec{RO}, 2HO).$$

Formulis istis autem docemur, quod $\frac{1}{15}(\text{RO}, 2\text{RO})$ suppositum esse $\frac{1}{15}(\text{R}\tilde{\text{O}}, 2\text{HO})$.

Similem suppositionem siliciae per aquam observamus in certis *amphibolibus* etc.

8) Posito autem siliciae et aequivalento $= 15,115$ formulae SiO omnes silicates, qui una cum silicia libera reperiuntur aut *acidi silicates* (bisilicates usque ad polysilicates) fiunt aut *neutrales* saltem combinationes (monosilicates), unde numerus *basicorum* silicatum (semisilicates usque ad oligosilicates) ad minimum redigitur.

9) L. GMELINUS *atomicum numerum* corporis cujusdam (et elementi et combinationis) nuncupat *quotum*, divisione ponderis specifici corporis cujusdam per pondus atomicum aequivalentumve ejus repertum. Atomicus igitur numerus quantitas est atomorum corporis cujuslibet in unitate spatii. Ad comparandos atomicos corporum numeros L. GMELINUS id volumen utpote spatii unitatem sumit, quod uno hydrogenii aequivalento repletum est et provocat ad formulam I. $\frac{770\text{ S}}{0,0693 \cdot \text{G}} = \text{Z}$, ut atomicos numeros elementorum eorumque praecipuas combinationes computet. Qua in formula S significat specificum corporis pondus, G corporis aequivalentum seu atomicum pondus, Z atomicum numerum, 770 specificum aquae pondus 4°C . (si pondus aëris atmosphaerici specificum $= 1$ ponitur in normali et temperatura et pressu) et 0,0693 specificum hydrogenii pondus (aëris pondus specificum $= 1$).

Quoad densitatum rationes guttatim fluidarum solidarumve *conjunctionum* ad densitates *partium* solida-

rum guttatimve fluidarum *constitutivarum* ex L. GMELINI sententia haec lex valet:

In chemica duorum corporum cum simplicium tum compositorum conjunctione minuitur illorum numerus atomicus et quidem in quadrato numeri aequivalentorum, quibus composita atomus formatur.

Haec lex sequenti formula describitur:

$$\text{II. } \frac{x \cdot Z' + y Z''}{(x + y)^2} = Z'''.$$

Ut verbis utar: combinationis cujusdam numerus atomicus non est medium numerorum atomicorum quoad partes combinationis ipsius constitutivas arithmeticum, sed summa atomicorum numerorum quoad partes combinationis ipsius constitutivas, divisa *quadrato* summae atomorum conjunctarum.

Ut redeamus ad formulam ipsam, signa ejusdem haec significant: Z' atomicum numerum *primae* partis constitutivae, Z'' *secundae*, Z''' *combinationis*, x numerum aequivalentorum *primae* et y *secundae* partis constitutivae, quae ad compositam atomum desiderantur.

In hac secunda formula momentum inest, quo adhibito atomicus numerus combinationis cujusdam et quidem notae stoechiometricae constitutionis ex atomicis numeris combinationis ipsius *elementorum* computari et cum computato secundum primam formulam atomico numero ejusdem *combinationis* comparari potest.

Quod ad combinationes *ignotae ambiguaeve* stoechiometricae constitutionis in lege ista, a L. GMELINO lata, etiam medium inest, unde haec ipsa constitutio firmari queat.

At valde dolendum est, quod, uti L. GMELINUS ipse

ingenue profitetur, lex modo nominata adhuc careat argumentis, unde firma ac certa comprobetur.

Posita vero lege ista utpote firma, videamus quae inde sequantur, quod attineat ad formulas SiO , vel SiO^2 , vel SiO^3 .

Ad silicii atomicum numerum edendum ante omnia specificum ejusdem pondus denotetur necesse est. Ex L. GMELINI dicto (cf, *Handb. d. Chemie* ed. IV. vol II. pag. 238) silicium gravius est oleo vitrioli; cujus cum pondus specificum = 1,848 sit, ponamus silicii = 2. Atomicus numerus densi solidique oxygenii (uti in solidis oxydis invenitur) cum L. GMELINO = 4200 (hypothethice) sumsimus.

$$\begin{aligned} \text{Ex } Z &= \frac{770 \text{ S}}{0,0693 \text{ G}} \text{ fit silicii atomicus numerus} \\ &= \frac{770 \cdot 2}{0,0693 \cdot 7,115} = 3123, \text{ si silicia} = \text{SiO sumitur;} \\ \text{numerus autem atomicus silicii fit} &= \frac{770 \cdot 2}{0,0693 \cdot 7,115 \cdot 2} \\ &= \frac{3123}{2} = 1561,5, \text{ si silicia} = \text{SiO}^2 \text{ sumitur;} \text{ denique} \\ \text{numerus iste fit} &= \frac{770 \cdot 2}{0,0693 \cdot 7,115 \cdot 3} = \frac{3123}{3} = 1041, \\ \text{si silicia} &= \text{SiO}^3 \text{ sumitur.} \end{aligned}$$

$$\text{Ex formula } \frac{xZ' + yZ''}{(x + y)^2} = Z''' \text{ fit}$$

$$\begin{aligned} 1) \text{ atomicus numerus siliciae SiO} &= \frac{1 \cdot 3123 + 4200}{(1 + 1)^2} \\ &= \frac{3123 + 4200}{4} = 1830,7; \\ 2) \text{ atomicus numerus siliciae SiO}^2 &= \frac{1 \cdot 1561,5 + 2 \cdot 4200}{(1 + 2)^2} \\ &= \frac{1561,5 + 8400}{9} = 11068; \end{aligned}$$

$$3) \text{ atomicus numerus siliciae } \text{SiO}^3 = \frac{1 \cdot 1041 + 3 \cdot 4200}{(1 + 3)^2} \\ = \frac{1041 + 12600}{16} = 852,56.$$

His tribus variis atomicis numeris ex *silicii* pondere specifico computatis cum siliciae atomicis numeris ex pondere *siliciae* specifico 2,652 secundum formulam

$$Z = \frac{770 \text{ S}}{0,0693 \text{ G}} \text{ computatis reperies:}$$

numerum atomicum siliciae

	SiO	SiO ²	SiO ³
si ex pondere specifico <i>siliciae</i> (2,651) secundum formulam I. computaveris	= 1951,3	= 973,9	= 649,2;
si ex pondere specif. <i>silicii</i> (=2) et atomorum numero oxygenii (=4200, computaveris)	= 1830,7	= 1106,8	= 852,6
Differentia	120,6	132,9	203,3.

Differentia ergo, si formulam SiO posueris, minima, unde haec formula quam maxime comprobare possit, nisi tota computatio ipsa nimio hypothetici laboret.

f. Aequivalento siliciae = 15,115 et formulae SiO lex Regnault-Neumanniana opponi queat, quod ex tabula sequente, nonnullorum oxydorum formula RO praedictum caloris capacitates continente, elucebit.

Tabula caloris capacitatum nonnullorum oxydorum formula RO gaudentium.

<i>Combinations.</i>	<i>Calores specifici.</i>	<i>Aequivalenta lenta.</i>	<i>Aequivalentorum caloris capacitates.</i>	<i>Scrutatores.</i>
Silicia . . = SiO	— 0,1719	— 15,115	— 2,5983	HERMANN.
Eadem . . = SiO	— 0,1913	— 15,115	— 2,8915	REGNAULT.
Magnesia . . = MgO	— 0,1696	— 20	— 3,3920	HERMANN.
Eadem . . = MgO	— 0,2439	— 20	— 4,8780	REGNAULT.
Eadem . . = MgO	— 0,2760	— 20	— 5,5200	NEUMANN.
Oxydum plumbi = PbO	— 0,0500	— 111,7	— 5,5850	AVOGADRO.
Calcia . . = CaO	— 0,1790	— 28	— 5,0120	AVOGADRO.
Eadem . . = CaO	— 0,3000	— 78	— 8,4000	HERMANN.
Glacies . . = HO	— 0,7200	— 9	— 6,4800	CLEMENT et DESORMES.
Eadem . . = HO	— 0,9200	— 9	— 8,2800	AVOGADRO.

Ex hac tabula siliciae aequivalentum $\equiv \text{SiO}$ multiplicatione cum calore suo specifico minorem aequivalenti sui caloris capacitatem exhibere, quam alia oxyda siliciae simili formula praedita, elucet.

Si autem *silicii* calorem specificum hypothetice posuerimus aequalem adamantis $\equiv 0,1469$, capacitas caloris unius aequivalenti *silicii* fit $\equiv 0,1469 \cdot 7,115 \equiv 1,0451935$. Cum addideris caloris capacitatem unius aequivalenti *oxygenii* $\equiv 0,231 \cdot 8 \equiv 1,8888$, tum siliciae aequivalenti caloris capacitatem $\equiv 2,934$ inuenies. Hic numerus e *silicii* calore specifico *hypothetico* computatus proximus est numero 2,8915, e *siliciae* calore specifico *invento*.

§. 16. Expositis his cunctis argumentis non diutius haesito, quin aequivalentum siliciae $\equiv 15,115$ ($\text{H} \equiv 1$) formulamque ejus $\equiv \text{SiO}$ (formulam aquae $\equiv \text{HO}$) accipiam. Hoc sumto mihi munus impositum est, silicatum formulas, siliciae aequivalento $\equiv 15,115$ fundamento posito, denuo computandi. Fines spatii in hoc libello mihi permissi transmigrarem, si cunctas formulas a me denuo computatas hoc in loco recepissem. Classificationem solummodo silicatum huic dissertationi addidi secundum diversum saturitatis cum silicia gradum. E numero silicatum maximo formulas tantum eorum addidi, qui mihi majoris momenti habendi videbantur. Ad has computandas formulas potissimum usus sum operibus sequentibus:

BERZELIUS, *Jahresberichte über die Fortschritte der physischen Wissenschaften*;

LIEBIGH et KOPPEL, *Jahresberichte über die Fortschritte der Chemie, Physik, Mineralogie und Geologie*;

RAMMELSBERGH, *Handwörterbuch des chemischen Theils der Mineralogie nebst Supplementen*;

L. GMELINI, *Handbuch der Chemie, edit. IV.; etc. etc.*

Aequivalenta elementorum et combinationum primi ordinis, quibus usus sum ad computandas formulas silicatum, in fine dissertationis collocata reperies.

Additamentum I

exhibens tabulam silicatum, partim nativorum, partim facitiorum, formula siliciae = SiO praeditorum.

In tota hac tabula formula RO aut RO⁺ significat aut unum aequivalentum cujuslibet basium sequentium aut unum aequivalentum mixtionis earum:

KO, NaO, LiO, BaO, SrO, CaO, MgO, MnO, FeO, ZnO, CuO, CeO, LaO, BeO, YO, ZrO;

formula R²O³ aut unum aequivalentum cujuslibet debilius basium aut unum aequivalentum mixtionis earum: Al²O³, Fe²O³, Mn²O³, Cr²O³;

formula RO unum aequivalentum SiO aut HO aut

BO ($= \frac{BO^3}{3}$) aut $\frac{1}{3}$ aequivalentum Al²O³ aut unum aequi-

valentum mixtionis horum oxydorum; litera m, n et x significant simplices numeros integros; litera Z unum aequivalentum oxygenii, seu fluorii, seu chlorii, seu sulphuris, seu mixtionis plurium horum elementorum electronegativorum. (Conf. §. 10 num. 12.)

Silicatum classis prima.

Monosilicates.

I. RO, SiO.

1) *Olivinus (chrysolithus, hyalosiderites)* *).

*) Mineralium nominibus germanica lingua syllaba *in* aut *ith* exeuntibus, terminationem *us* (scilicet *lapis* seu λίθος) tribui; iis, quae syllaba *it* terminantur, exitum *ites* (ob similitudinem cum vocabulis *pyrites*, *siderites*, in classicis jam scriptoribus usitatis).

2) *Batrachites*; 3) *Tephroites*; 4) *Knebelites*; 5) *Willemites*; 6) *Troostites*; 7) *Zirconus*; 8) *Phenacites*.

9) *Monosilicas oxyduli ferri* (crystalla in scoriis reperta, quae prodeunt ex purificatione ferri fusi: *Kry-stalle aus Eisenfrischschlacke*).

II. $\overset{+}{R}Z, \bar{R}Z$.

10) *Helvinus* = $(8 \text{ BeO}, 7 \text{ MnO}, 2\frac{1}{2} \text{ MnS}, \text{FeO}) + (17\frac{1}{2} \text{ SiO}, \text{HO}) = 18\frac{1}{2} (\overset{+}{R}Z, \bar{R}Z)$.

III. $\text{RO}, \text{SiO} + x \text{HO}$.

11) *Villarsites*; 12) *lapis calaminaris* (*Kieselgal-me*); 13) *Cerites*; 14) *Malaconus*; 15) *Thorites*; 16) *Orangites*.

IV. $\text{R}^2\text{O}^3, \text{SiO}$.

17) *Lapis manganicus* prope St. Marcel inventus (*Braunsteinerz von St. Marcel*).

V. $\text{R}^2\text{O}^3, \text{SiO} + x \text{HO}$.

18) *Schroetterites*; 19) *Scarbroides*; 20) *Umbra*.

VI. $\text{RO}, \text{SiO} + \text{RO}^2, \text{SiO}$.

21) *Titanites* = $\text{CaO}, \text{SiO} + \text{TiO}^2, \text{SiO}$. *Schorla-mites* = $4 (\text{CaO}, \text{SiO}) + \text{Fe}^2 \text{O}^3, \text{SiO} + 2 \text{TiO}^2, \text{SiO}$, (conf. Nro. 89).

VII. $m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, \text{SiO})$.

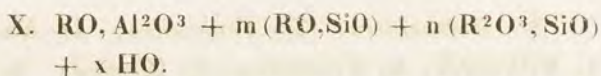
22) Minerale quod „*Chloritspath von Kosoibrod*“ vocamus, secundum ERDMANNI analysin huc pertinet.

VIII. $m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, \text{SiO}) + x \text{HO}$.

23) *Chloritoides* (*Sismondinus*); 24) *Gehlenites*; 25) *Cronstedtites*; 26) *Chlorites*; 27) *Ripidolithus*; 28) *Penninus*; 29) *Aphrosiderites*.

IX. $\text{RO}, \text{Al}^2\text{O}^3 + m(\text{RO}, \text{SiO}) + n(\text{R}^2\text{O}^3, \text{SiO})$.

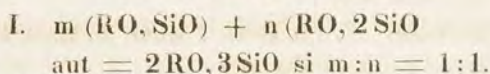
30) *Sapphirinus*.



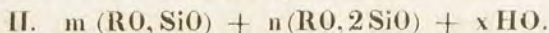
31) *Disterrites*; 32) *Seybertites*; 33) *Xanthophyllites*; 34) *Gedrites*.

Classis secunda.

Monodisilicates.

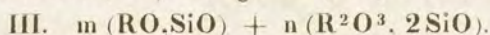


35) *Boltonites*; 36) *Leucophanus*.

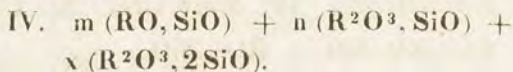


37) *Serpentinus* (s. *nobilis et vulgaris et picrolithus*); 38) *Chrysotilis*; 39) minerale quod „*Schillerspath*“ vocamus.

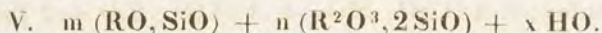
40) *Deweylithus*; 41) *Gymnites*; 42) *Hydrophites*; 43) *Marmolithus*; 44) *Antigorites*; 45) *Williamsites*.



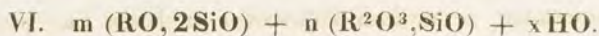
46) *Euklasis*.



47) *Humboldilithus*.



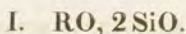
48) *Delessites*; 49) *Vermiculites*; 50) *Chonicrites*; 51) *Clingmannites*; 52) *Corundelithus*; 53) *Kaemmererites*.



54) *Epichlorites*; 55) *Emeryllites*.

Classis tertia.

Disilicates.



56) *Disilicas kalicus* (H. ROSE); 57) *Wollastonites*.

58) *Augites (pyroxenus)*.

Pyroxeni, alumiae expertes, formula gaudent $\text{RO}, 2\text{SiO}$ e. c. *diopsides, salites, malacolithus, hedenbergites, pyroxenus ferrosus* et *rhodonites*.

Pyroxeni alumiam continentes formulam $n(\text{RO}, 2\text{SiO}) + (\text{RO}, 3\text{SiO})$ praebent; $n = 1$ usque ad 9; alumia locum tenet aequivalentis partis siliciae. El. c.

Augites communis, in valle quae Fassa dicitur reperi-
tus, secundum analysin KUDERNATSCH =
 $(17 \text{ CaO}, 16 \text{ MgO}, 8 \text{ FeO}) + (2 \text{ Al}^2\text{O}^3, 80 \text{ SiO})$
 $= 41 \text{ R}\ddot{\text{O}} + 86 \text{ R}\bar{\text{O}} = 10 \text{ R}\ddot{\text{O}} + 21 \text{ R}\bar{\text{O}} =$
 $9 (\text{RO}, 2\text{SiO}) + (\text{RO}, 3\text{SiO})$.

Jeffersonites, secundum HERMANNI analysin =
 $(4 \text{ CaO}, 3 \text{ MgO}, 2 \text{ FeO}, \text{ MnO}, \text{ ZnO}) +$
 $(\frac{1}{3} \text{ Al}^2\text{O}^3, 26 \text{ SiO}, \text{ HO}) = 11 \text{ R}\ddot{\text{O}} + 28 \text{ R}\bar{\text{O}} =$
 $5 (\text{R}\ddot{\text{O}}, 2\text{R}\bar{\text{O}}) + 6 (\text{R}\ddot{\text{O}}, 3\text{R}\bar{\text{O}})$ aut simplici for-
mula $\text{R}\ddot{\text{O}}, 2\text{R}\bar{\text{O}} + \text{R}\ddot{\text{O}}, 3\text{R}\bar{\text{O}}$ respondens.

59) *Diallagus et Bronzites* simili modo variant at-
que augites.

60) *Nephrites*; 61) minerale quod „*Rothbraunstein-erz*“ vocamus.

62) *Disilicas ferrosus* ex scoriis fornacum ferro
eliquescendo inservientium.

II. $\text{RO}, 2\text{SiO} + x \text{ HO}$.

63) *Disilicas natricus nativus ac factitius* (secun-
dum analyses FRITZSCHE, HERMANNI, KRAFFTII et DE-
LAHAYE).

64) *Monradites*; 65) *Picrosminus*; 66) *Picrophylli-*
thus; 67) *Aphrodites*; 68) *Dioptasis*.

III. $\text{R}^2\text{O}^3, 2\text{SiO}$.

69) *Cyanites (disthenus, sillimanites, bucholzites,*
fibrolithus, rhaetizites).

70) *Andalusites* (SILLIMANNI); 71) *Chiasolithus* (RENOVII).

72) *Myelinus*. Inde a numero 69 usque ad numerum 72 = $\text{Al}^2\text{O}^3, 2\text{SiO}$.

73) *Topazius* = $\text{Al}^2\text{F}^3, 2\text{SiF} + 6 (\text{Al}^2\text{O}^3, 2\text{SiO})$, secundum BERZELII analysin;

= $\text{Al}^2\text{F}^3, 3\text{SiF} + 8 (\text{Al}^2\text{O}^3, 2\text{SiO})$, secundum FORCHHAMMERI analysin.

IV. $\text{R}^2\text{O}^3, 2\text{SiO} + x\text{HO}$.

74) *Miloschinus*; 75) *Collyrites*; 76) *Allophanus firmianus*; 77) *Stalactites ferricus* ex fodina „Himmelfahrt“ prope Friburgia Saxonum.

V. $m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 2\text{SiO})$.

78) *Anorthites*.

A = formulae normali; $m:n = 1:1$,

B = $m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$;

$m:n = 1:1$.

79) *Lepolithus*.

80) *Amphodelithus* = $\text{RO}, 2\text{SiO} + \text{Al}^2\text{O}^3, 2\frac{1}{2}\text{SiO}$.

81) *Nephelinus (elaeolithus)*

A = formulae normali,

B = $\text{RO}, 2\text{SiO} + \text{R}^2\text{O}^3, 2\frac{1}{2}\text{SiO}$,

C = $\text{RO}, 2\text{SiO} + \text{R}^2\text{O}^3, 3\text{SiO}$.

82) *Sodalithus* = nephelino cum NaCl conjuncto.

83) *Cancrinites* = nephelino cum CaO, CO² aut NaO, CO² aut ambobus salibus conjuncto.

84) *Noseanus* = nephelino cum NaO, SO³ + H₂O conjuncto.

85) *Hauynus* = nephelino cum CaO, SO³ conjuncto.

86) *Scolopsites* = nephelino cum CaO, SO³ et NaCl conjuncto.

87) *Itnerites* = nephelino cum CaO , SO^3 et Na Cl et HO conjuncto.

88) *Ephesites*.

89) *Schorlamites* = $2 (\text{CaO}, 2\text{SiO}) + \text{Fe}^2\text{O}^3, 2\text{SiO} + 2 (\text{CaO}, \text{TiO}^2)$.

VI. $m (\text{RO}, 2\text{SiO}) + n (\text{R}^2\text{O}^3, 2\text{SiO}) + x \text{HO}$.

90) *Lindsayites*; 91) *Prehnites*; 92) *Thomsonites* (*comptonites*); 93) *Carpholithus*.

Classis quarta.

Monotrisilicates.

I. $m (\text{RO}, \text{SiO}) + n (\text{RO}, 3\text{SiO})$.

aut = $\text{RO}, 2\text{SiO}$, si $m:n = 1:1$.

Huc adnumerandi sunt pyroxeni alumiam continentes (conf. nr. 58).

II. $m (\text{RO}, \text{SiO}) + n (\text{R}^2\text{O}^3, 3\text{SiO})$.

aut = $\text{RO}, 2\text{SiO} + \text{R}^2\text{O}^3, 2\text{SiO}$, si $m:n = 1:1$.

94) *Epidotus*

A = *epidotus calcicus* (*zoisites*):

$m:n = 1:1$ aut $13:12$ aut $9:7$ aut $7:5$ aut $3:2$ aut $3:1$.

B = *epidotus ferricus* (*pistazites*):

$m:n = 2:3 - 3:4 - 6:5 - 4:3 - 3:2 - 2:1 - 3:1$.

Puskinites et *Bucklandites* adnumerandi sunt epidotis ferricis, quibus $m:n = 2:1$.

C = *epidotus manganicus*:

$m:n = 7:5$ aut $7:4$.

95) *Allanites*

A = formulae normali; $m:n = 4:1$ aut $3:1$,

B = $4 (\text{RO}, \text{SiO}) + \text{Al}^2\text{O}^3, 3\frac{1}{2}\text{SiO}$,

C = $4 (\text{RO}, \text{SiO}) + \text{Al}^2\text{O}^3, 4\text{SiO}$.

96) *Orthites*

A = formulae normali; m:n = 4:1 aut 3:1 aut 7:3,

B = 3 (RO, SiO) + R²O³, 2½ SiO,

C = 5 (RO, SiO) + R²O³, 4 SiO,

D = 7 (RO, SiO) + R²O³, 5½ SiO.

Orthitarum plurimi plus minusve aquae continent.

97) *Granatus*; m : n (casibus plurimis) = 3 : 1; interdum aut 2:1 aut 5:2 aut 4:1.

98) *Pyropius*; m:n = 3:1.

99) *Vesuvianus (idokrasis)*; m:n = 3:1 aut 4:1 aut 5:1.

100) *Wernerites* prope Tunaberg et Pargas repertus secundum Walmstadtii et Nordenskiöldi analyses = CaO, SiO + Al²O³, 3 SiO.

101) *Mejonites*; 102) *Sarkolithus*; 103) *Lievrites* (Ilvaïtes).

104) *Micae magnesiae*

A = formulae normali; m:n = 3:1 — 4:1 — 5:1 — 6:1 — 7:1,

B = m (RO, SiO) + n (R²O³, 4 SiO); m : n = 4:3 — 2:1 — 3:1 — 4:1 — 5:1,

C = m (RO, SiO) + n (R²O³, 5 SiO); m:n = 4:1.

105) *Micae ferruginosae*

m (RO, SiO) + n (R²O³, 3½ SiO); m : n = 5:4 — 1:1 — 1:2.

Lepidomelanus HAUSMANNI, mica prope Abborfors reperta (SVANBERG), et mica fuscoviridis e protogino *Montis Albi* (Delesse) hanc compositionem exhibent.

III. m (RO, SiO) + n (R²O, 3 SiO) + x HO.

Mineralia nonnulla ordinis praecedentis ex parte

huic ordini adnumeranda sunt, e. c. *Orthitae* et *micae* species quaedam.

106) *Atheriastites*; 107) *Latrobites* (diploites).

Classis quinta.

Ditrisilicates.

I. $m(\text{RO}, 2\text{SiO}) + n(\text{RO}, 3\text{SiO})$.

aut $= 2\text{RO}, 5\text{SiO}$, si $m:n = 1:1$.

108) *Amphibolis* (tremolites, *Hornblende*)

$m:n = 1:1 - 2:1 - 3:1 - 4:1 - 5:1$.

109) *Hypersthenus* (paulites); $m:n = 1:1$.

110) *Babingtonites*; $m:n = 1:1$. 111) *Steatites anhydrici*; $m:n = 2:1 - 1:1 - 1:2 - 1:3$.

II. $m(\text{RO}, 2\text{SiO}) + n(\text{RO}, 3\text{SiO}) + x\text{HO}$.

112) *Talcum*

A = formulae normali; $m:n = 1:1$ (formula creberrima); tum $= 1:2 - 3:1 - 5:1$,

B = $\text{MgO}, 2\text{SiO} + x\text{HO}$ (formula rarius inventa)

$x = \frac{1}{15}$ usque ad 1 (conf. SCHEERER's analyses talci varietatum in LIEBIG et KOPP's *Jahresbericht für 1851*).

113) *Steatites* (*Speckstein*)

A) *Steatites anhydricus* (conf. nr. 111).

B) *Steatites hydricus* $= 2\text{MgO}, 5\text{SiO} + x\text{HO}$;

$x = \frac{1}{2} - 3$.

114) *Pectolithus*; 115) *Krokydolitus*; 116) *Stellites* prope Bergenhill repertus.

117) *Barsowites*.

III. $m(\text{R}^2\text{O}^3, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$.

118) *Pycnites* $= 2(\text{Al}^2\text{O}^3, 2\text{SiO}) + 3(\text{Al}^2\text{O}^3, 3\text{SiO}) + 4\text{F} = 4\text{O}$.

IV. $m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$.

119) *Scapolithus* (nuttalithus, stroganovites, eckeborgites, glaucolithus, dipyris)

$$\text{A} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO}); m:n = 1:1 - 4:3 - 3:2,$$

$$\text{B} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\frac{1}{2}\text{SiO}); m:n = 3:2 - 5:4,$$

$$\text{C} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 4\text{SiO}); m:n = 1:1 - 7:9 - 2:1,$$

$$\text{D} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 4\frac{1}{2}\text{SiO}); m:n = 3:4,$$

$$\text{E} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 5\text{SiO}); m:n = 1:1 - 4:3,$$

$$\text{F} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 5\frac{1}{2}\text{SiO}); m:n =$$

5:4. Maxima pars formulae $\text{RO} = \text{CaO}$ aut CaO et NaO ; maxima pars formulae $\text{R}^2\text{O}^3 = \text{Al}^2\text{O}^3$. Pluribus scapolithis CaO , CO^2 admixtus est.

120) *Saussurites* (lemanites, Jade)

$$\text{A} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 2\text{SiO}),$$

$$\text{B} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO}),$$

$$\text{C} = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\frac{1}{2}\text{SiO}) + x\text{HO}.$$

121) *Turmalinus*

$$\text{A} = m(\overset{+}{\text{R}}\text{O}, 2\bar{\text{R}}\text{O}) + n(\text{R}^2\text{O}^3, 3\bar{\text{R}}\text{O})$$

$$\overset{+}{\text{R}}\text{O} = \text{KO}, \text{NaO}, \text{LiO}, \text{MgO}, \text{MnO}, \text{FeO}$$

$$\text{R}^2\text{O}^3 = \text{Al}^2\text{O}^3, \text{Fe}^2\text{O}^3$$

$$\bar{\text{R}}\text{O} = \text{SiO} \text{ et } \text{BO} (= 11,633)$$

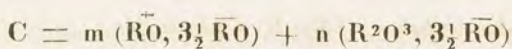
$$m:n = 4:3 - 1:1 - 5:6 - 4:5 - 3:4 -$$

$$2:3 - 1:2 - 3:7 - 2:5 - 1:3,$$

$$\text{B} = m(\overset{+}{\text{R}}\text{O}, 3\bar{\text{R}}\text{O}) + n(\text{R}^2\text{O}^3, 3\bar{\text{R}}\text{O})$$

$$\overset{+}{\text{R}}\text{O}, \text{R}^2\text{O}^3 \text{ et } \bar{\text{R}}\text{O} \text{ idem significant, ac in A;}$$

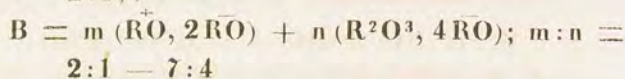
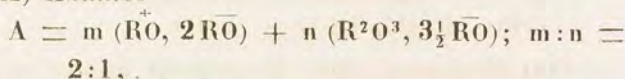
$$m:n = 1:1 - 2:3 - 1:2 - 1:3 - 1:4,$$



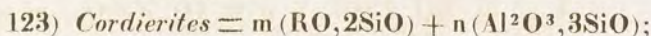
$m:n = 1:5$. Significatio $R\bar{O}$, R^2O^3 , $R\bar{O}$ eadem ac in A.

Ad computandas turmalini formulas usus sum Ram-
melsbergii analysibus recentissimis. Turmalinus for-
mula C praeditus dilapsione paulisper mutatus esse
videtur.

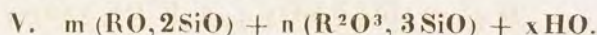
122) *Axinites*



$R\bar{O}$, R^2O^3 , $R\bar{O}$ significant idem ac in turma-
lini formulis.



$m:n = 1:1 - 6:5 - 5:4$.



124) *Palagonites* (quasi scapolithus hydraticus,
Bunsen.)

125) *Esmarcites*; 126) *Chlorophyllithus*; 127) *Pra-*
seolithus; 128) *Gigantolithus*; 129) *Fahlunites*; 130)
Ottrelithus; 131) *Bonnsdorffites*; 132) *Brevicites*;
133) *Mesolis*; 134) *Huronites*; 135) *Kerolithus*; 136)
Saponites.

Classis sexta.

Trisilicates.

I. $RO, 3SiO$.

137) *Trisilicas calcicus*, prope Aedelforss et Gjel-
lebaeck repertus, secundum BERZELII et HISINGERI
analyses.

138) *Eudialytes*; 138) b) *Chladnites*.

139) *Danburites* = $\text{RO}, 3\text{BO} + 4(\text{RO}, 3\text{SiO})$.

II. $\text{RO}, 3\text{SiO} + x\text{HO}$.

140) *Stilpnomelanus*, 141) *Chlorophaeites*; 142) *Spuma maris*.

III. $\text{R}^2\text{O}^3, 3\text{SiO}$.

143) *Xenolithus* = $\text{Al}^2\text{O}^3, 3\text{SiO}$.

IV. $\text{R}^2\text{O}^3, 3\text{SiO} + x\text{HO}$.

144) *Pholerites*; 145) *Terra flava ambergensis*.

V. $m(\text{RO}, 3\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$.

146) *Rhyakolithus*; $m:n = 1:1$.

147) *Labrador*

$A = m(\text{RO}, 2\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$; $m:n = 9:11$,

$B = m(\text{RO}, 3\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$; $m:n = 1:1 - 4:5$,

$C = m(\text{RO}, 3\frac{1}{2}\text{SiO}) + n(\text{R}^2\text{O}^3, 3\frac{1}{2}\text{SiO})$; $m:n = 1:1 - 8:9$.

148) *Couzeranites*; 149) *Isopyris*; 150) *Xylithus*.

151) Minerale quod „*Porzellanspath*“ vocamus: = $4(\text{CaO}, 3\text{SiO} + \text{Al}^2\text{O}^3, 3\text{SiO}) + \text{NaCl}$.

152) *Micae kalinae*

$A = m(\text{RO}, 3\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$

$\text{RO} = \text{KO}, \text{NaO}, \text{CaO}, \text{MgO}, \text{FeO}, \text{MnO}$

$\text{R}^2\text{O}^3 = \text{Al}^2\text{O}^3, \text{Fe}^2\text{O}^3$.

Portiuncula oxygenii fluoro supposita.

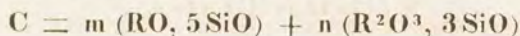
$m:n = 4:5 - 1:2 - 3:7 - 4:9 - 1:3$,

$B = m(\text{RO}, 4\text{SiO}) + n(\text{R}^2\text{O}^3, 3\text{SiO})$

RO et R^2O^3 idem significat ac in A.

Portiuncula oxygenii fluoro supposita

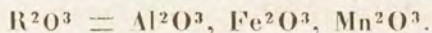
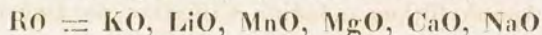
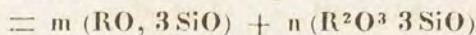
$$m:n = 1:2 - 1:3 - 1:4,$$



$$m:n = 1:3; \text{ cetera simulatque in A.}$$

Plurimae micae kalinae paullulum aquae continent.

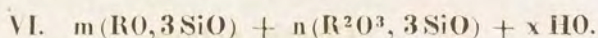
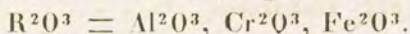
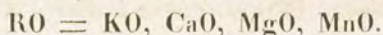
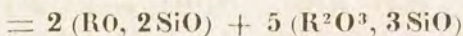
153) *Micae lithionicae (lepidolithi)*



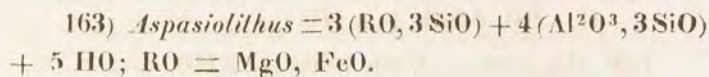
Haud paucae oxygenii quantitates substituuntur fluori aequivalenti quantitate.

$$m:n = 3:2 - 1:1 - 3:5.$$

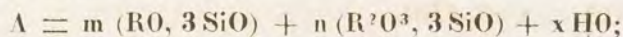
154) *Micae chromicae*



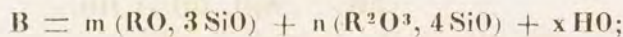
155) *Natrolithus* (mesotypus natricus); 156) *Scolezites*; 157) *Mesolithus*; 158) *Phacolithus*; 159) *Zeaconites* (Gismondinus); 160) *Punalithus*; 161) *Rosellanus*; 162) *Pyrargyllithus*.



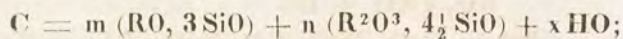
164) *Pinites*



$$m:n = 1:1 - 2:3,$$



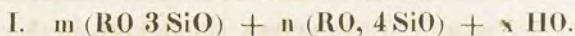
$$m:n = 1:3,$$



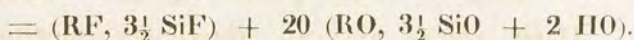
$$m:n = 1:1.$$

Classis septima.

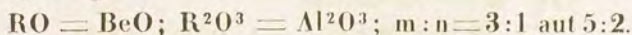
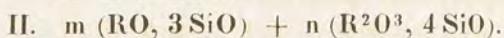
Tritetrasilicates.



$\text{RO} = \text{KO}, \text{CaO}; n = 4 \text{ et plus,}$
e c. *Apophyllithus* e fodina Cliffmine in America septentrionali



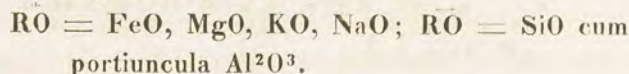
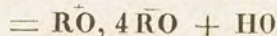
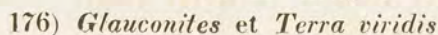
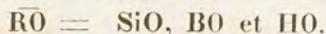
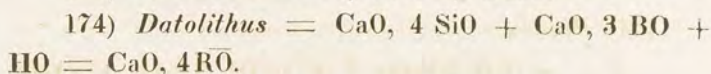
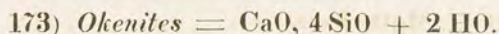
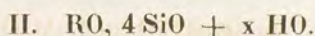
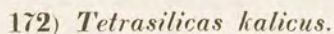
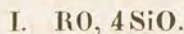
C. T. JACKSON.



167) *Wichtynus*; 168) *Lerynus*; 169) *Algerites*;
170) *Sericites*; 171) *Onkosinus*.

Classis octava.

Tetrasilicates.



III. $R^2O^3, 4SiO + xHO$.

177) *Pinguites*; 178) *Hisingerites*; 179) *Bolus fuscus* (secundum H. WACKENRODERI analysin); 180) *Medulla rupium* prope Rochlitz reperta; 181) *Halloysites*; 182) *Tuésites*.

183) *Argilla ad fabricanda fumisugia* (Argilla communis ex parte).

184) *Kaolinus* (Argilla porcellanea)

$A = Al^2O^3, 4SiO + 2HO$ (formula frequentissima),

$B = Al^2O^3, 4SiO + 3HO =$ Argilla porcellanea passoviensis.

IV. $m(RO, 4SiO) + n(R^2O^3, 4SiO)$.

185) *Leucites*; $m:n = 1:1$.

185) *Andesinus*

$A = RO, 4SiO + R^2O^3, 4SiO$,

$B = RO, 4SiO + R^2O^3, 4\frac{1}{2}SiO$,

$C = RO, 4SiO + R^2O^3, 5SiO$.

Andesini nonnulli *aquae* portiunculam continent.

V. $m(RO, 4SiO) + n(R^2O^3, 4SiO) + xHO$.

187) *Sacharites*; 188) *Analcimus*; 189) *Eudnophites*; 190) *Ledererites*; 191) *Caporcianites*.

192) *Laumontites*

$A = CaO, 4SiO + Al^2O^3, 4SiO + 4HO$,

$B = CaO, 4SiO + Al^2O^3, 5SiO + 4HO$.

193) *Phillipsites* (*Harmatomus calcicus*)

$A = RO, 3SiO + R^2O^3, 3SiO + 3\frac{1}{2}HO$,

$B = m(RO, 4SiO) + n(R^2O^3, 4SiO) + xHO$;

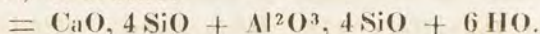
$m:n = 3:4 - 5:6 - 1:1$,

$C = m(RO, 4SiO) + n(R^2O^3, 5SiO) + xHO$.

194) *Gmelinites*

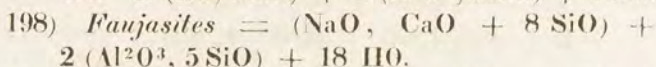
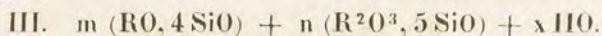
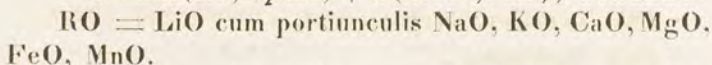
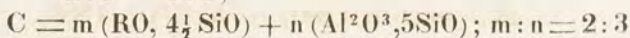
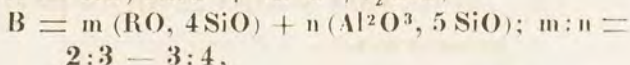
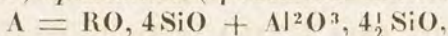
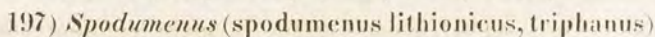
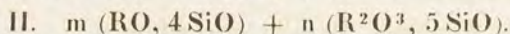
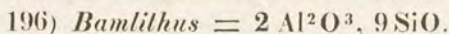
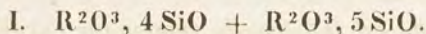
$A = RO, 4SiO + Al^2O^3, 4SiO + 6HO$,

$B = RO, 4SiO + Al^2O^3, 5SiO + 7HO$.

195) *Chabasites*

Classis nona.

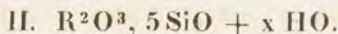
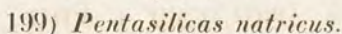
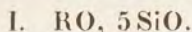
Tetrapentasilicates.



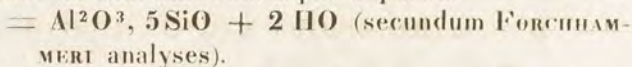
Huc etiam plures *andesini*, *laumontitae*, *phillipsitae* et *gmelinitae* varietates numerandae sunt.

Classis decima.

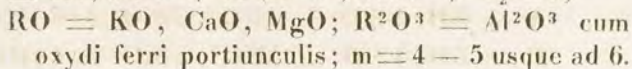
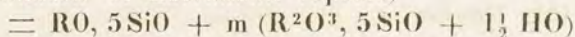
Pentasilicates.



200) *Argilla hassiaca* (prope Allmeroda reperta) agitatione et elutione cum aqua depurata



Argilla nassovica depurata (prope Baumbach, Grenzhausen et Ebernhahn reperta)



Argilla nassovica depurata prope *Benndorf* reperta
 $= \text{RO}, 5\text{SiO} + 8 (\text{R}^2\text{O}^3, 4\frac{1}{2}\text{SiO} + 1\frac{1}{2}\text{HO}).$

Argilla nassovica depurata prope *Hillscheid* reperta
 $= 2 (\text{RO}, 3\frac{1}{2}\text{SiO}) + 9 (\text{R}^2\text{O}^3, 3\frac{1}{2}\text{SiO} + 2\text{HO}).$

(*Argillae nassovicae* secundum has *Fresenii* analyses continent vel plus vel minus siliciae quam kaolini varietates).

III. $m (\text{RO}, 5\text{SiO}) + n (\text{R}^2\text{O}^3, 5\text{SiO}).$

201) *Oligoklas* (*spodumenus natricus*)

A $= m (\text{RO}, 3\text{SiO}) + n (\text{R}^2\text{O}^3, 4\text{SiO}); m:n = 3:2 = 4:3,$

B $= m (\text{RO}, 4\text{SiO}) + n (\text{R}^2\text{O}^3, 4\text{SiO}); m:n = 5:4,$

C $= m (\text{RO}, 4\text{SiO}) + n (\text{R}^2\text{O}^3, 4\frac{1}{2}\text{SiO}); m:n = 1:1,$

D $= m (\text{RO}, 4\text{SiO}) + n (\text{R}^2\text{O}^3, 5\text{SiO}); m:n = 1:1 = 5:4,$

E $= m (\text{RO}, 4\frac{1}{2}\text{SiO}) + n (\text{R}^2\text{O}^3, 5\text{SiO}); m:n = 6:7,$

F $= m (\text{RO}, 5\text{SiO}) + n (\text{R}^2\text{O}^3, 5\text{SiO}); m:n = 3:2 = 1:1 = 4:5 = 5:6 = 6:7,$

G $= m (\text{RO}, 5\text{SiO}) + n (\text{R}^2\text{O}^3, 6\text{SiO}); m:n = 1:1,$

RO $= \text{NaO}, \text{CaO}, \text{MgO},$ cum vestigiis FeO et MnO

$\text{R}^2\text{O}^3 = \text{Al}^2\text{O}^3, \text{Fe}^2\text{O}^3,$ interdum cum portunculis $\text{Cr}^2\text{O}^3.$

202) *Loxoklas* A $= \text{RO}, 4\text{SiO} + \text{R}^2\text{O}^3, 5\text{SiO},$

B $= \text{RO}, 5\text{SiO} + \text{R}^2\text{O}^3, 5\text{SiO}.$

203) *Acmites* A $= \text{NaO}, 4\text{SiO} + \text{Fe}^2\text{O}^3, 5\text{SiO},$

B $= 5 (\text{NaO}, 5\text{SiO}) + 4 (\text{Fe}^2\text{O}^3, 5\text{SiO}) + 2\text{HO}.$

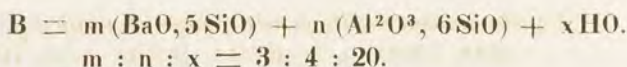
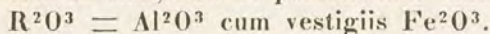
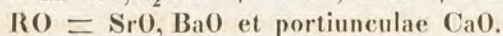
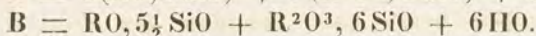
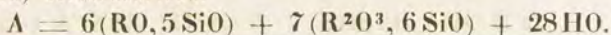
IV. $m (\text{RO}, 5\text{SiO}) + n (\text{R}^2\text{O}^3, 5\text{SiO}) + x\text{HO}.$

204) *Leonhardites*; $m : n : x = 3 : 4 : 12.$

205) *Harmotomus* (*harmotomus baryticus*).

A $= m (\text{BaO}, 5\text{SiO}) + n (\text{Al}^2\text{O}^3, 5\text{SiO}) + x\text{HO};$

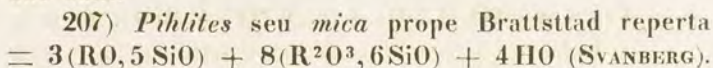
$m : n : x = \text{aut } 1 : 1 : 5 \text{ aut } 4 : 5 : 24.$

206) *Brewsterites*.

Classis undecima.

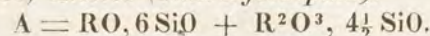
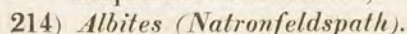
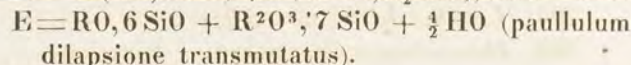
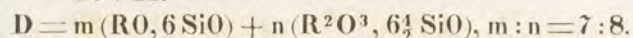
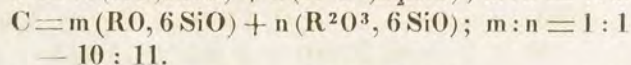
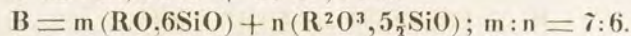
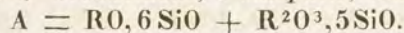
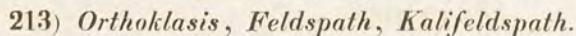
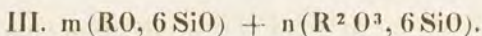
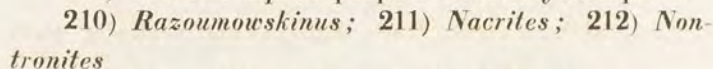
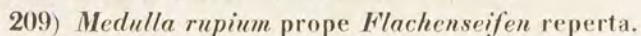
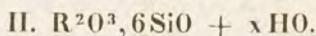
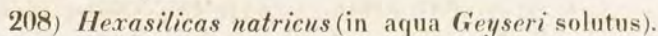
Penthexasilicates.

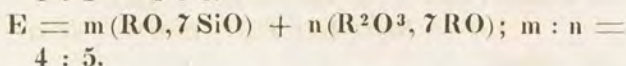
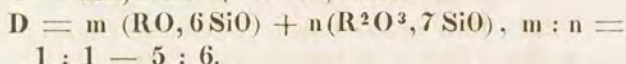
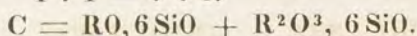
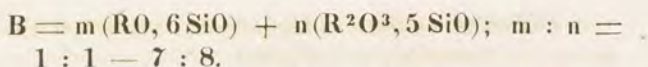
Huic classi nonnullae varietates *orthoklasis* (conf. class. 12. num. 213), *oligoklasis*, *harmotomi* et *brewsteritae* (conf. class. 10, num. 201, 205 et 206) adnumerandae sunt.



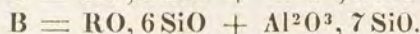
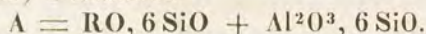
Classis duodecima.

Hexasilicates.

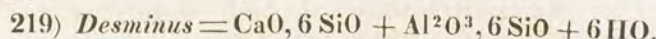
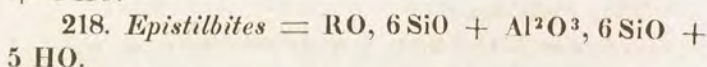
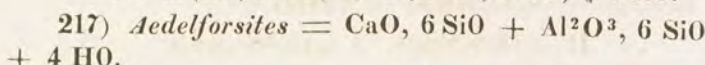
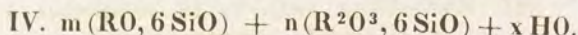
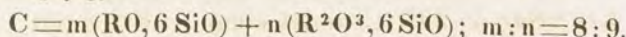
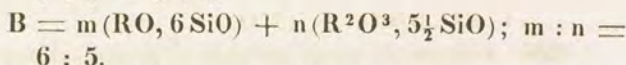
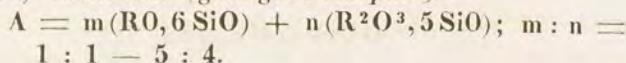
I. $\text{RO}, 6\text{SiO}$.



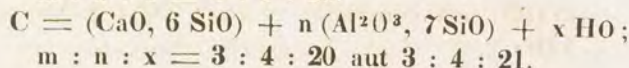
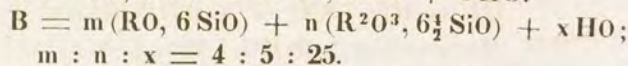
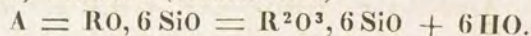
215) *Periklinus*.



216) *Sanidinus (glasiger Feldspath)*.

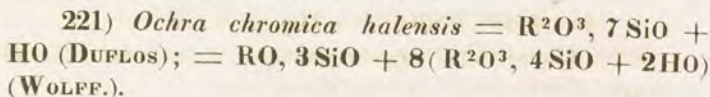
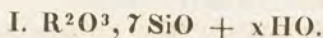


220) *Stilbites (Heulandites)*.



Classis decima tertia.

Heptasilicates.



Ochra chromica waldenburgica = $R^2O^3, 6SiO + HO,$
 $R^2O^3 = Al^2O^3, Cr^2O^3, Fe^2O^3.$

II. $m(RO, 7SiO) + n(R^2O^3, 7SiO).$

222) *Mica* prope Jviken in Dalarna (Suecia) reperta
 = $2(RO, 7SiO + R^2O^3, 7SiO) + HO.$

$RO = MgO, KO, CaO; R^2O^3 = Al^2O^3, Fe^2O^3$
 (SVANBERG).

Huic classi porro adnumerandae sunt nonnullae
albitae et *petalitae* varietates (conf. No. 214 et No. 225).

Classis decima quarta.

Octosilicates.

I. $RO, 8SiO + xHO.$

223) *Vitrum in aqua solubile* FUCHSI siccatum =
 $KO, 8SiO + 2HO; candefactum = KO, 8SiO.$

224) *Octosilicas natricus* in temperatura $117^{\circ}C$
 siccatus = $NaO, 8SiO + 12HO.$

II. $m(RO, 8SiO) + n(R^2O^3, 8SiO).$

225) *Petalites.*

$A = m(LiO, 7SiO) + n(Al^2O^3, 7SiO); m:n = 1:1.$

$B = m(RO, 8SiO) + n(Al^2O^3, 8SiO); m:n = 3:4.$

$C = m(RO, 8SiO) + n(Al^2O^3, 9SiO); m:n = 5:4.$

226) *Krablites* = $5(RO, 8SiO) + 6(R^2O^3, 8\frac{1}{2}SiO).$

III. $m(RO, 7SiO) + n(R^2O^3, 8SiO) + xHO.$

227) *Baumontites* = $9(RO, 7SiO) + 8(Al^2O^3, 8SiO)$
 + $43HO; seu simplicius = CaO, 7SiO + Al^2O^3, 8SiO$
 + $5HO.$

Classis decima quinta.

Enneasilicates.

I. $R^2O^3, 9SiO.$

228) *Agalmatolithus* = $Al^2O^3, 9SiO.$

II. $R^2O^3, 9SiO + xHO.$

229) *Cimolithus argentieraceus* = $Al^2O^3, 9SiO$
 + $3HO.$

230) *Augitae nonnullae varietates dilapsae* compositionem habent cimolitho similem (*Rammelsberg*).

231) *Anthosiderites* = $\text{Fe}^2\text{O}^3, 9\text{SiO} + \text{HO}$.

III. $m(\text{RO}, 9\text{SiO}) + n(\text{R}^2\text{O}^3, 9\text{SiO}) + x\text{HO}$.

232) *Neurolithus* = $4(\text{RO}, 9\text{SiO} + \text{HO}) + 7(\text{Al}^2\text{O}^3, 9\text{SiO} + \text{HO})$.

Classis decima sexta.

Polysilicates.

a) Decasilicates.

I. $m(\text{RO}, 10\text{SiO}) + n(\text{R}^2\text{O}^3, 10\text{SiO})$.

233) *Obsidianus*.

Varietates obsidiani hucusque inquisitae formulas habent inter $4(\text{RO}^3, 5\frac{1}{2}\text{SiO}) + (\text{Al}^2\text{O}^3, 6\text{SiO})$ et

$\text{RO}, 14\text{SiO} + \text{Al}^2\text{O}^3, 14\text{SiO}$ jacentes; nonnulli obsidiani formulam $m(\text{RO}, 10\text{SiO}) + n(\text{R}^2\text{O}^3, 10\text{SiO})$ exhibent.

II. $m(\text{RO}, 10\text{SiO}) + n(\text{R}^2\text{O}^3, 10\text{SiO}) + x\text{HO}$.

234) *Lapis piceus*; ejusdem compositio inter formulas $2(\text{RO}, 9\text{SiO}) + (\text{Al}^2\text{O}^3, 9\text{SiO}) + 2\text{HO}$ et

$\text{RO}, 13\text{SiO} + 3(\text{R}^2\text{O}^3, 13\frac{1}{2}\text{SiO}) + 9\text{HO}$ variat; lapis piceus prope Newry repertus = $\text{RO}, 10\text{SiO} + \text{Al}^2\text{O}^3, 10\text{SiO} + 4\text{HO}$ (Knox).

b) Endekasilicates.

235) *Leelites*.

a) L. prope Gryphyttan repertus = $\text{Al}^2\text{O}^3, 11\text{SiO}$ (CLARKE).

b) Leelites secundum Thomsoni analysin = $3(\text{KO}, 11\text{SiO}) + 3(\text{FeO}, 11\text{SiO}) + 2(\text{Al}^2\text{O}^3, 11\text{SiO})$.

c) Dodecasilicates.

236) *Baulites* = $\text{RO}, 12\text{SiO} + \text{Al}^2\text{O}^3, 12\text{SiO}$;

$\text{RO} = \text{KO}, \text{NaO}, \text{CaO}, \text{FeO}, \text{MgO}, \text{MnO}$.

237) *Lapis argillaceus* prope Misniam repertus = $\text{KO}, 12\text{SiO} + 2(\text{Al}^2\text{O}^3, 12\text{SiO}) + \text{HO}$.

238) *Lapis pumicis*

$2(\text{RO}, 9\text{SiO}) + 3(\text{R}^2\text{O}^3, 9\text{SiO})$ usque ad formulam
 $\text{RO}, 12\text{SiO} + 5(\text{R}^2\text{O}^3, 12\text{SiO})$.

d) Triskaidekasilicates.

239) *Malthacites* prope Steindorffel repertus

$= \text{Al}^2\text{O}^3, 13\text{SiO} + 16\text{HO}$.

240) *Lapis margaritaceus* (sphaerulithus) formulas
 exhibet inter

$2(\text{RO}, 6\text{SiO}) + (\text{R}^2\text{O}^3, 6\text{SiO})$ et $5(\text{RO}, 13\text{SiO}) +$
 $9(\text{R}^2\text{O}^3, 13\text{SiO} + 7\text{HO})$ jacentes.

e) Hekkaidekasilicates, Hekkatriakontasilicates,
 Octokaitessarakontasilicates et Dekaihebdomekondasilicates.

241) $\text{KO}, 16\text{SiO}$ } *Hypersilicates kalici* a
 242) $\text{KO}, 36\text{SiO} + 9\text{HO}$ } Forchhammero exami-
 243) $\text{KO}, 48\text{SiO} + 16\text{HO}$ } nati.

244) $\text{NaO}, 72\text{SiO} + 4\text{HO}$ *Hypersilicas natricus* a
 Forchhammero examinatus.

Classis decima septima.

Oligosilicates.

a) Semisilicates.

245) *Chamoisites*.

$= 10(2\text{FeO}, \text{SiO} + 2\text{HO}) + (2\text{Al}^2\text{O}^3, \text{SiO} + 2\text{HO})$.
 BERTHIER.

246) *Silicas ferrosus in forma fabarum* (Bohnerz),
 qui ad vicum Kandern reperitur $=$

$5(2\text{FeO}, \text{SiO} + 2\text{HO}) + (\text{Al}^2\text{O}^3, 3\text{SiO})$.

247) *Heteroklinus* $= 2\text{Mn}^2\text{O}^3, \text{SiO}$.

b) Tritosilicates,

248) *Cruzites* $= 3\text{CaO}, \text{SiO} + 7(3\text{Fe}^2\text{O}^3, \text{SiO})$.
 THOMSON.

249) *Nemalites* $3\text{MgO}, \text{SiO} + 4\text{HO}$. THOMSON.

Additamentum II

*exhibens aequivalentia illorum elementorum
et illarum conjunctionum, quae computandis
silicatum formulis praecedentibus
inserviebant.*

<i>Nomina ele- mentorum.</i>	<i>For- mulae.</i>	<i>Aequiva- lenta.</i>	<i>Nomina conjunctionum.</i>	<i>For- mulae.</i>	<i>Aequi- valenta.</i>
Aluminium	= Al	= 13,7	Alumina	= Al ₂ O ₃	= 51,4
Baryum	= Ba	= 68,5	Baryta	= BaO	= 76,5
Beryllium	= Be	= 4,7	Beryllia	= BeO	= 12,7
Borium	= B	= 3,633	Boracicum acidum	= BO	= 11,633
Calcium	= Ca	= 20	Calcia seu calx	= CaO	= 28
Carboneum	= C	= 6	Acidum carbonicum	= CO ₂	= 22
Cerium	= Ce	= 47	Oxydulum cerii	= CeO	= 55
Chlorum	= Cl	= 35,5	Acidum hydrochloricum	= HCl	= 36,5
Chromium	= Cr	= 26,7	Oxydulum chromii	= CrO	= 34,7
			Oxydum chromii	= Cr ₂ O ₃	= 77,4
Cuprum	= Cu	= 31,7	Oxydum cupri	= CuO	= 39,7
Ferrum	= Fe	= 28	Oxydulum ferri	= FeO	= 36
Fluorum	= F	= 19	Oxydum ferri	= Fe ₂ O ₃	= 80
Hydrogenium	= H	= 1	Aqua	= HO	= 9
Kalium	= K	= 39,2	Kali	= KO	= 47,2
Lanthanum	= La	= 47	Oxydum lanthani	= LaO	= 55
Lithium	= Li	= 6,5	Oxydum lithii	= LiO	= 14,5
Magnium	= Mg	= 12	Magnesia	= MgO	= 20
Manganum	= Mn	= 27,6	Oxydulum mangani	= MnO	= 35,6
			Oxydum mangani	= Mn ₂ O ₃	= 79,2
Natrium	= Na	= 23	Natrum	= NaO	= 31
Niccolum	= Ni	= 29,6	Oxydulum niccoli	= NiO	= 37,6
Oxygenium	= O	= 8			
Phosphorus	= P	= 31	Acidum phosphoricum	= PO ₅	= 71
Plumbum	= Pb	= 103,6	Oxydum plumbi flayum	= PbO	= 111,6
Silicium	= Si	= 7,1 ^{*)}	Silicia	= SiO	= 15,1
Stannum	= Sn	= 58	Acidum stannicum	= SnO ₂	= 74
Strontium	= Sr	= 43,8	Strontia	= SrO	= 51,8
Sulphur	= S	= 16	Acidum sulphuricum	= SO ₃	= 40
Thorium	= Th	= 59,6	Thoria	= ThO	= 67,6
Titanum	= Ti	= 25	Acidum titanicum	= TiO ₂	= 41
Zincum	= Zn	= 32,6	Oxydum zinci	= ZnO	= 40,6
Zirconium	= Zr	= 22,4	Zirconia	= ZrO	= 30,4

^{*)} Loco numeri 7,1152.

Theses defendendae.

I.

Elementorum aequivalentia, quibus hydrogenii aequivalentum = 1, illis ubi oxygenii aequivalentum = 100 seu = 10, praefero.

II.

Distributio elementorum in metalla et metalloïdas rationi chemicae non sufficit.

III.

Definitio leviorum metallorum, utpote metallorum, quorum specificum pondus minus quam 5, argumentis probetur necesse est.

IV.

Mineralium dilapsio potissimum oxygenii, aquae et acidi carbonici actione efficitur, mediante calore.

V.

Substantiarum organicarum quantitates in terra arabili fusione terrae cum oxydo plumbi ex plumbo sejuncto certiores reperiuntur, quam aliis methodis adhibitis.

Thema: Hellenismus

1. Hellenismus: Begriff und Entstehung
Hellenismus: griechische Kultur im römischen Reich
Entstehung: 1. v. Chr. - 1. n. Chr.

2. Hellenismus: Verbreitung und Wirkung
Verbreitung: von Griechenland nach Westen
Wirkung: auf die römische Kultur

3. Hellenismus: Kunst und Literatur
Kunst: Skulpturen, Architektur
Literatur: Dichtung, Prosa

4. Hellenismus: Philosophie und Wissenschaft
Philosophie: Platon, Aristoteles
Wissenschaft: Mathematik, Naturwissenschaften

5. Hellenismus: Religion und Ethik
Religion: Götterkult, Mystik
Ethik: Lebensweise, Moral



















